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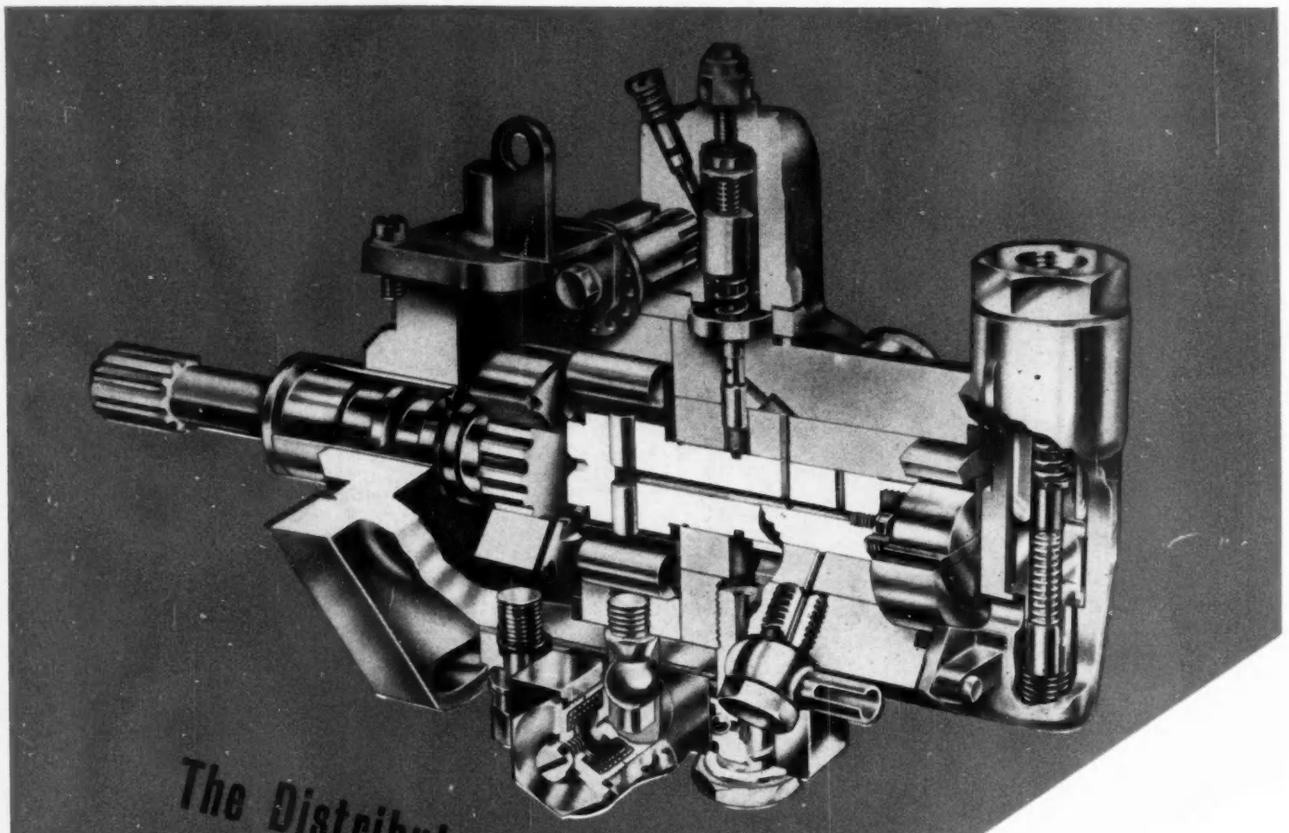
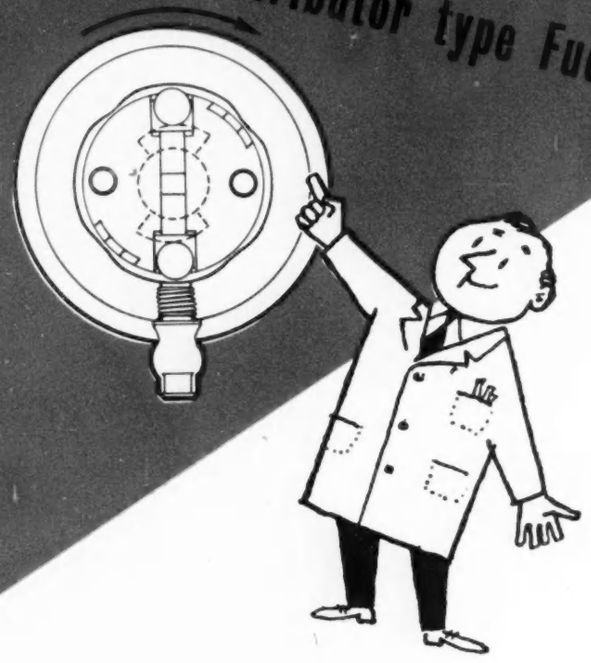


The Distributor type Fuel Injection Pump



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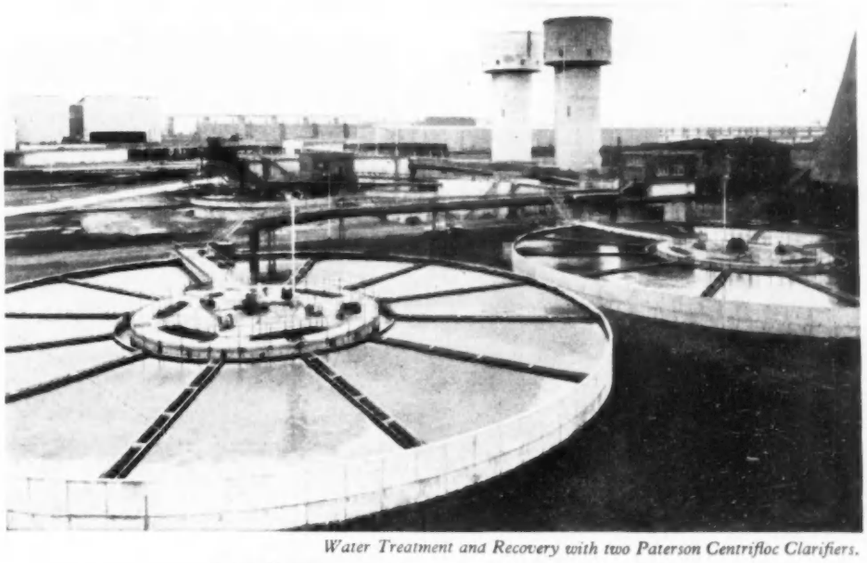

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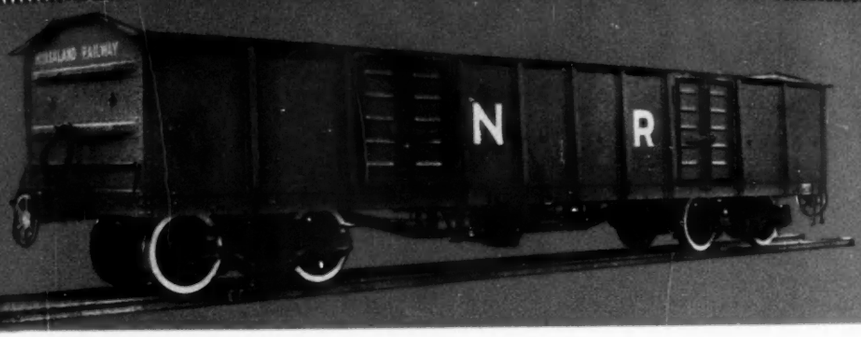

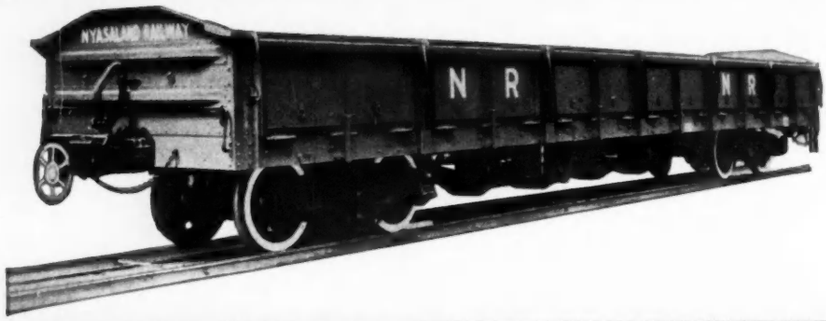

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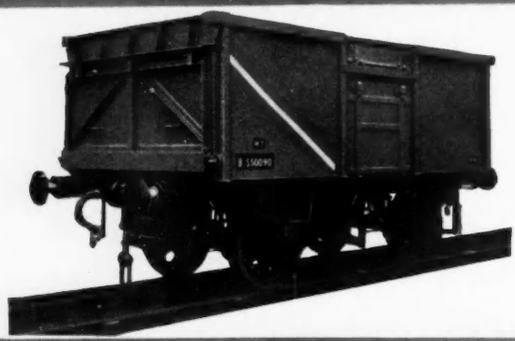
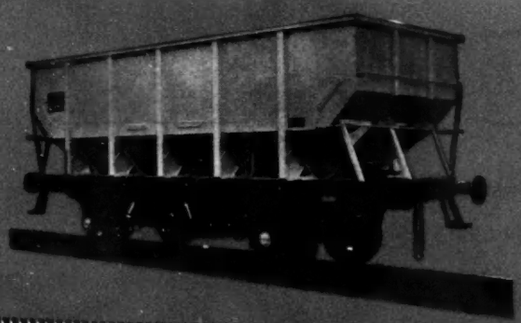


1 & 2 *drop-sided and high-sided 35-ton bogie wagons built by Cambrian Wagon & Engineering Company Ltd. for Nyasaland Railways. Appleby-Frodingham Kuplus steel was used for the platework of the high-sided wagon, and with mild steel for the platework of the drop-sided wagon.*

3 & 4 *Appleby-Frodingham plates and sections were used in the construction of the 16-ton mineral wagon and the 21-ton hopper wagon built by The Birmingham Railway Carriage & Wagon Co. Ltd. for British Railways.*



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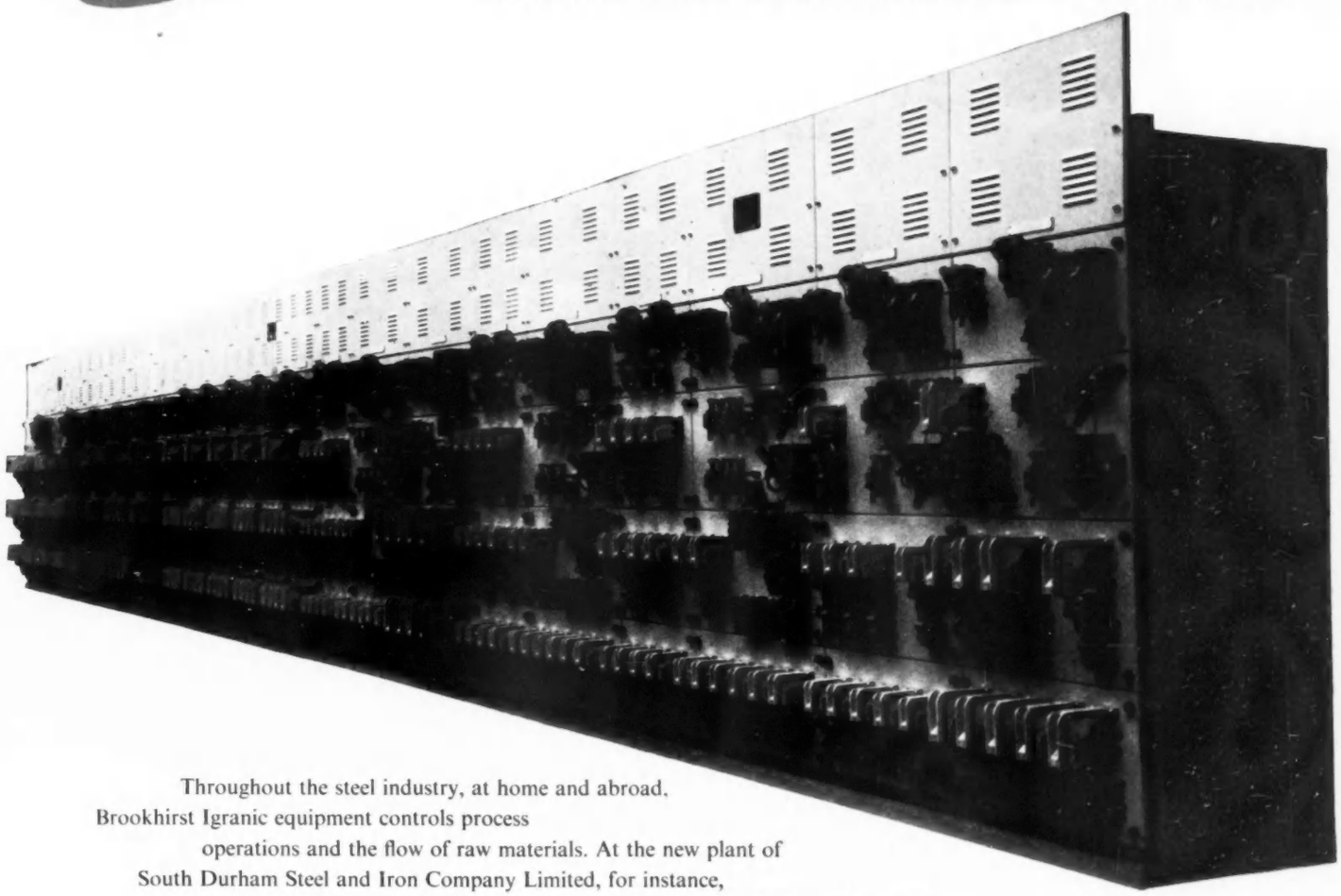

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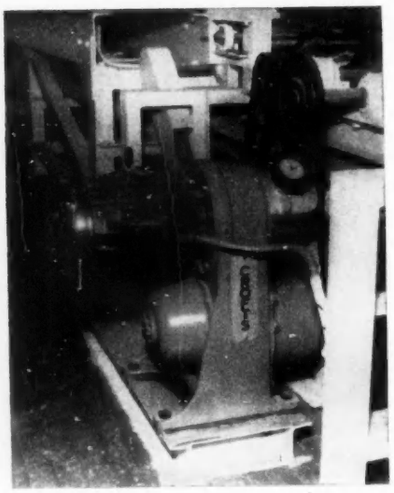

A Vertical Unit in use on cereal processing machinery. (Guards removed for clarity.)

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Inspecting the sealing angle of a poppet valve. This component is required to have a surface finish of 2 micro-inches and a roundness to within 1/50,000 in. measured on any diameter. (*Nurnberg photograph for* ENGINEERING.)

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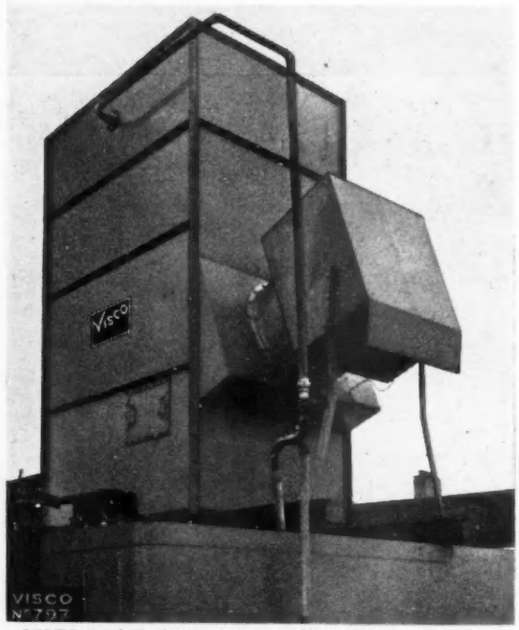

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The required date for completion is August, 1961.
Tender documents, which will be available from 12th August, 1960, and returnable by 12 noon on 19th September, 1960, may be obtained on application to THE RESIDENT ENGINEER, THE ELECTRICITY CORPORATION OF NIGERIA, ADELPHI, JOHN ADAM STREET, LONDON, W.C.2, on receipt of a payment by cheque for £12 in favour of The Electricity Corporation of Nigeria. This payment will not be refunded.
The Electricity Corporation of Nigeria do not bind themselves to accept the lowest or any Tender, nor will they be responsible for any costs incurred by Tenderers in making their Tender. C 722

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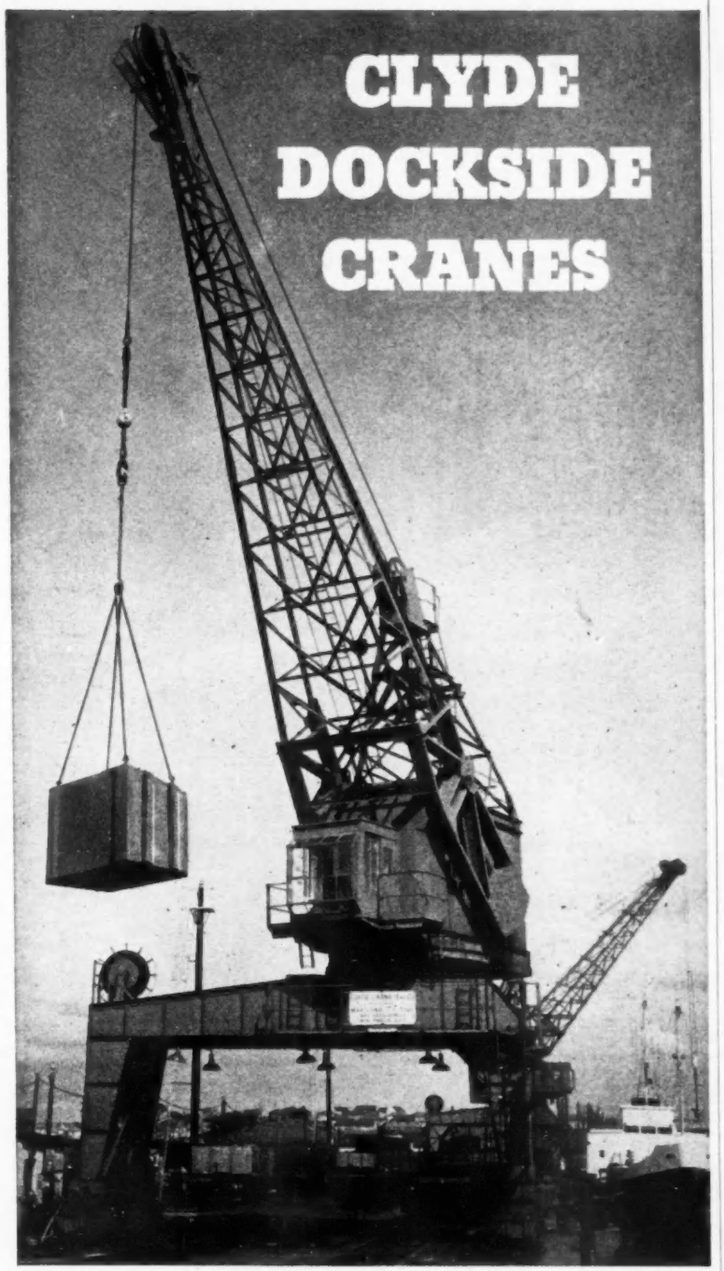

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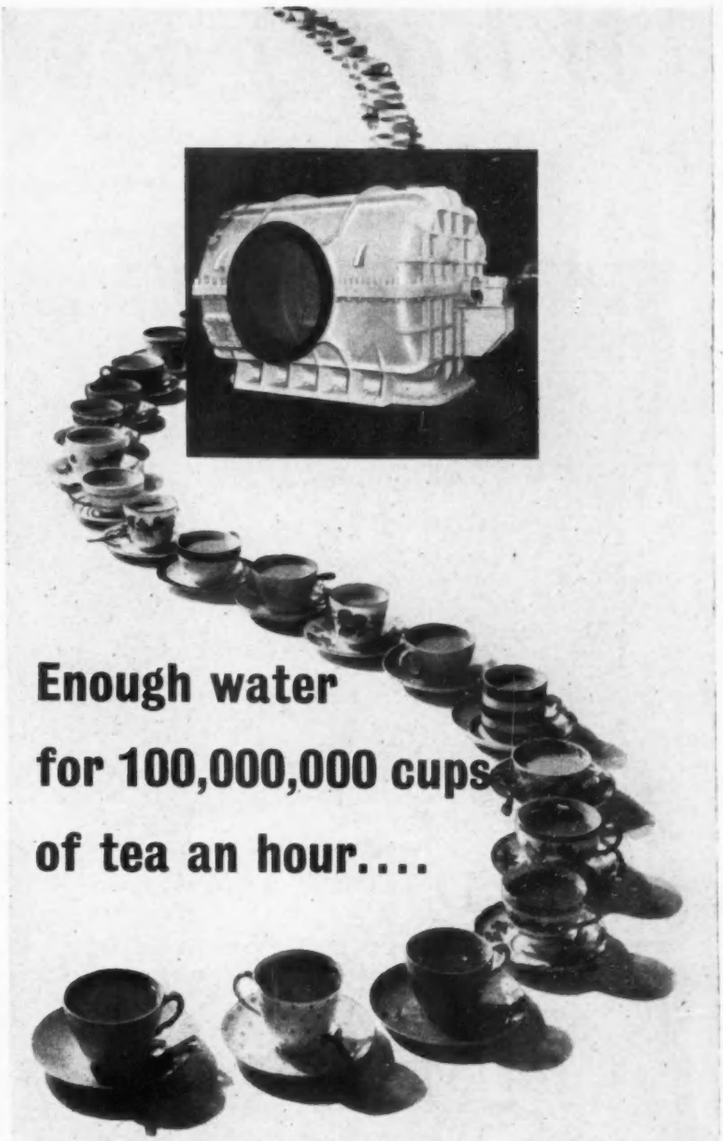

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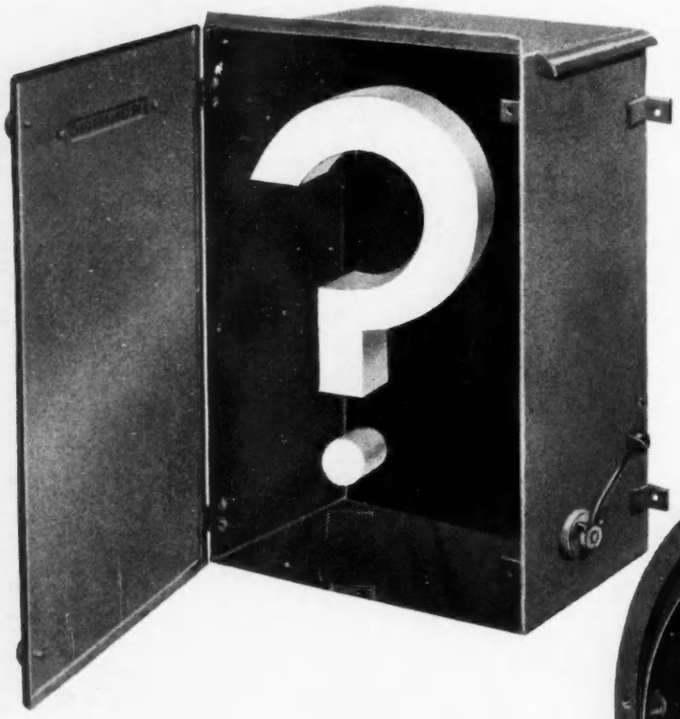

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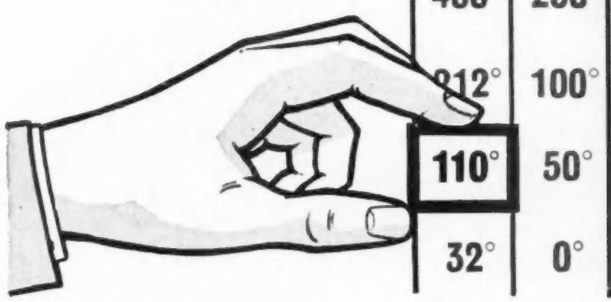

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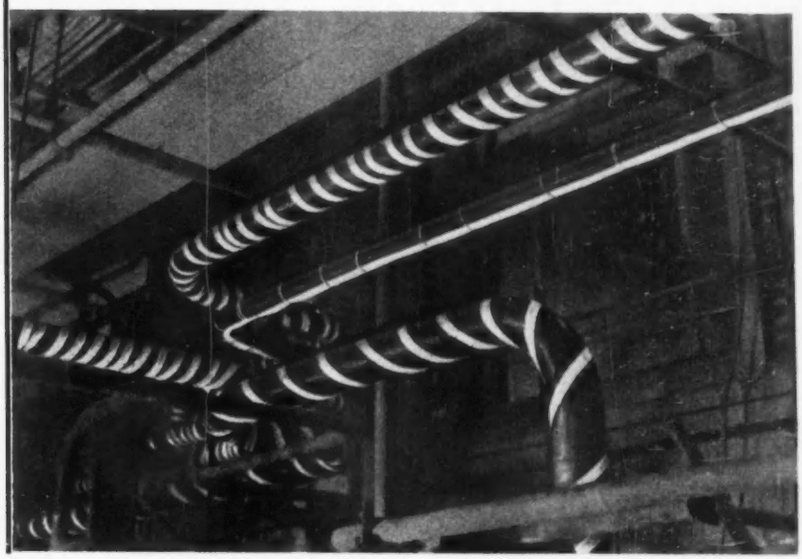

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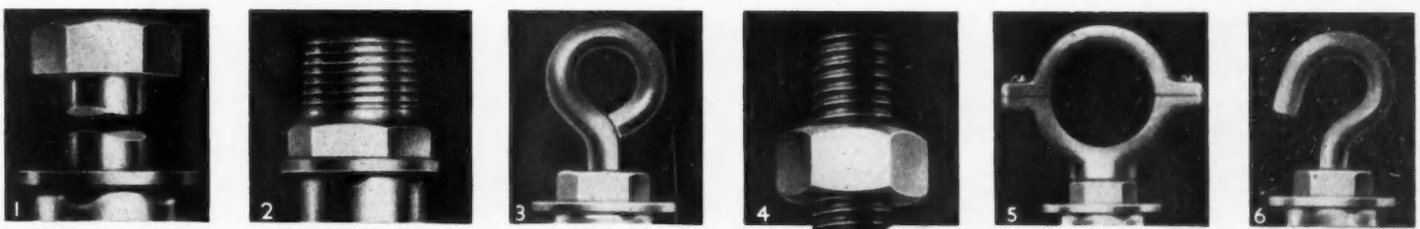

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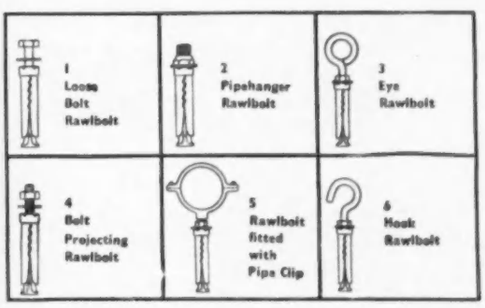

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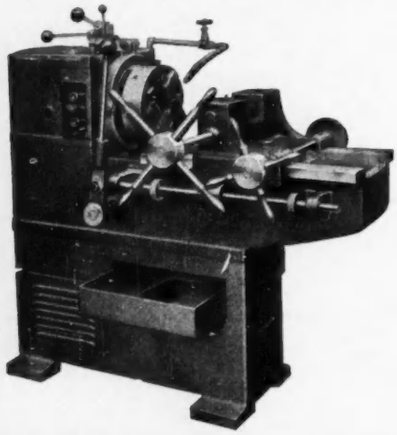

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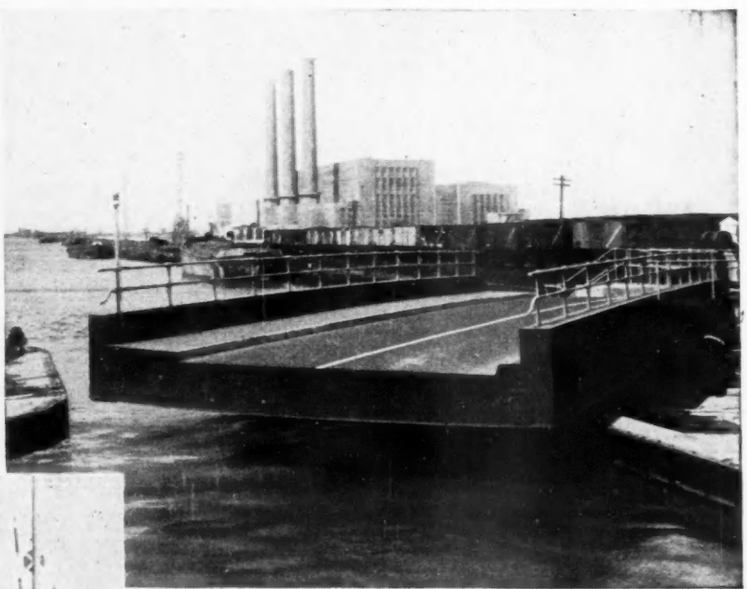

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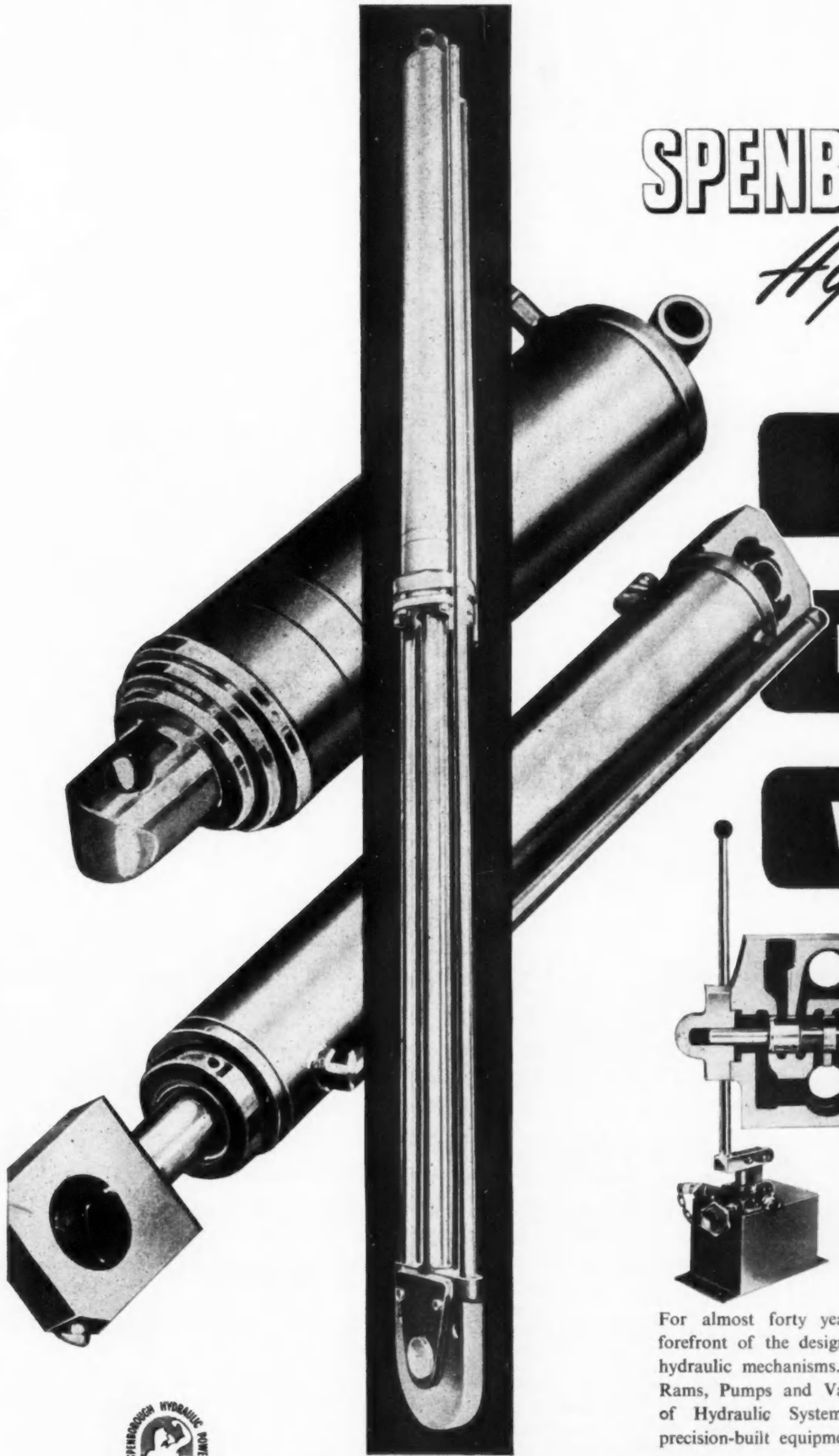

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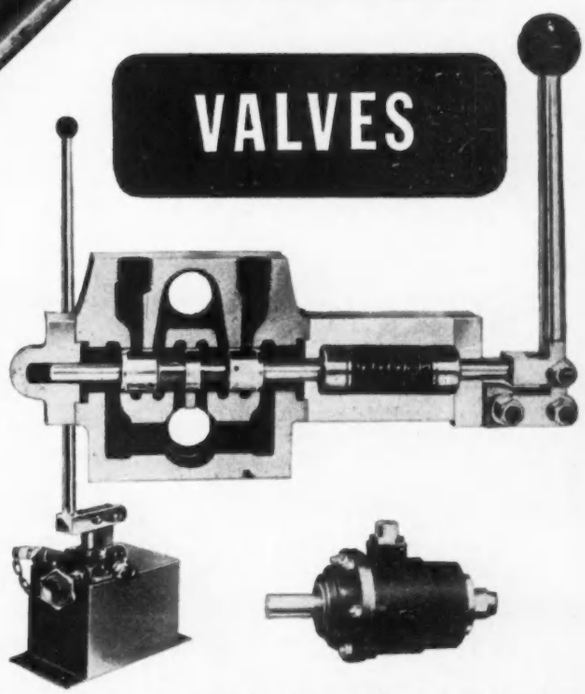

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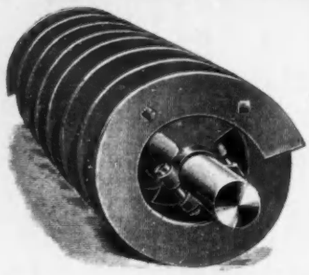

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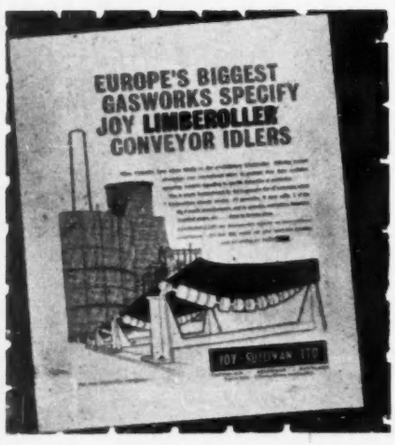

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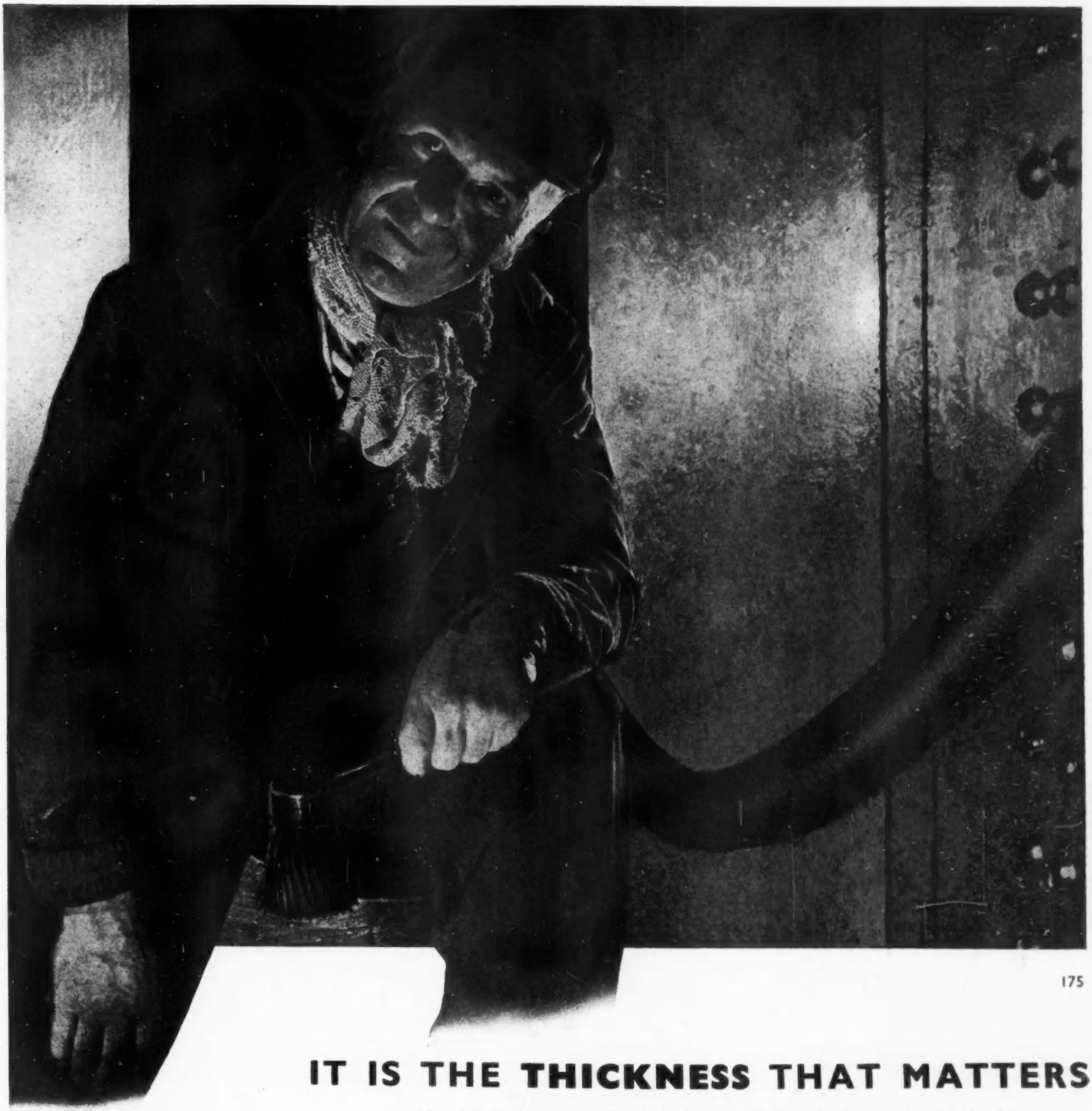

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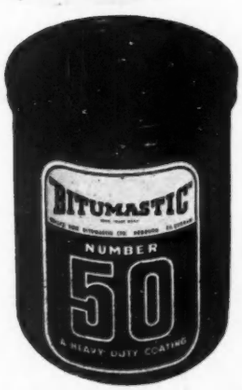
IT IS THE THICKNESS THAT MATTERS

How often do you think of *thickness* when you judge a paint coating? This vital third dimension has a considerable bearing on its life and performance. In fact, it can be said that all other things being equal, the thicker the coating, the longer the period of protection. 'Bitumastic' No. 50 can be applied in thicknesses far in excess of those obtained from normal painting. No priming coat is required on metal surfaces and being thixotropic, 'Bitumastic' No. 50 will not run on vertical surfaces. The next time you have a corrosion problem—try 'Bitumastic' No. 50, the *heavy duty* coating.



BITUMASTIC No. 50

A black coal-tar-pitch coating for tough corrosive conditions.

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SENDZIMIR Cold Strip Mills

For rolling all types of ferrous and non-ferrous metals up to 120 inches wide

Sendzimir Mills are built under licence by Robertsons.
They have constructed all types of these mills (Strip Mills, Sheet Mills and Planetary Hot Mills) and have the specialist knowledge and skill so essential for the accurate machining to the very closest tolerances demanded in their manufacture.

The main advantages of Sendzimir Cold Strip Mills are as follows—

Large reduction at each pass
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Extreme accuracy of gauge
High standard of surface finish
Small work rolls render use of tungsten carbide rolls economical
Quick and easy roll changes
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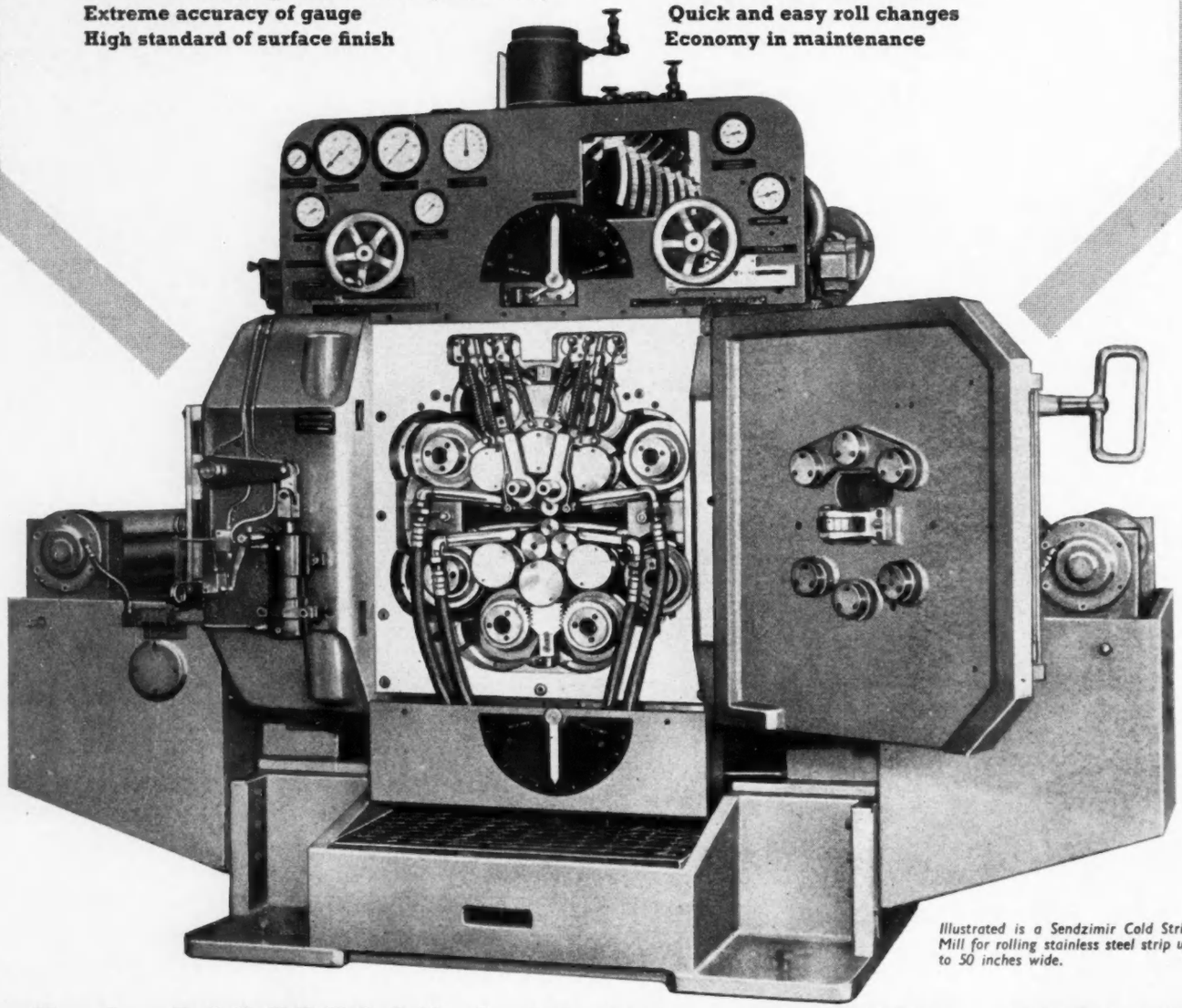

Illustrated is a Sendzimir Cold Strip Mill for rolling stainless steel strip up to 50 inches wide.

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LICENSEES FOR THE BUILDING OF SENDZIMIR COLD REDUCTION MILLS AND PLANETARY HOT MILLS, HALLDEN GUILLOTINE AND ROTARY FLYING SHEAR MACHINES AND TORRINGTON METAL WORKING MACHINERY.

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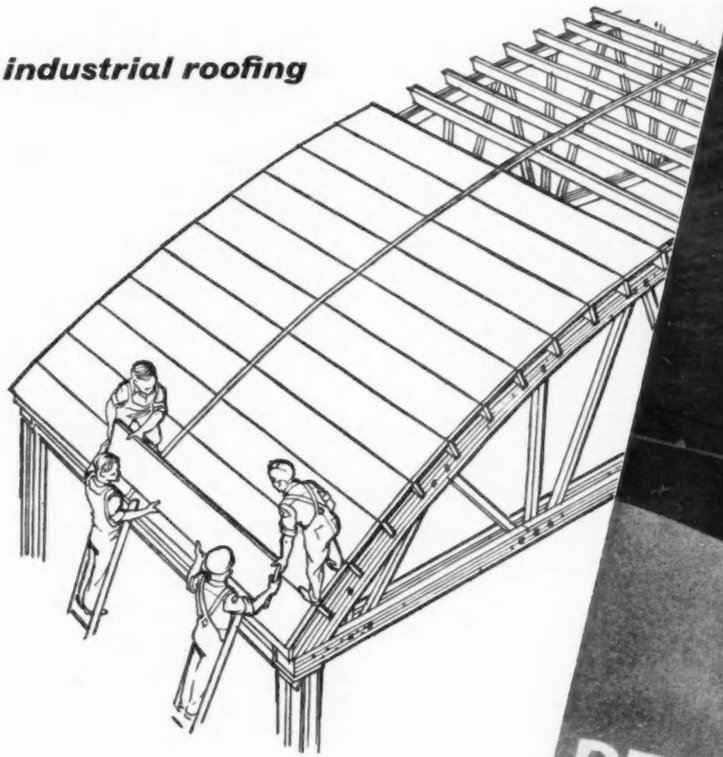
For industrial roofing



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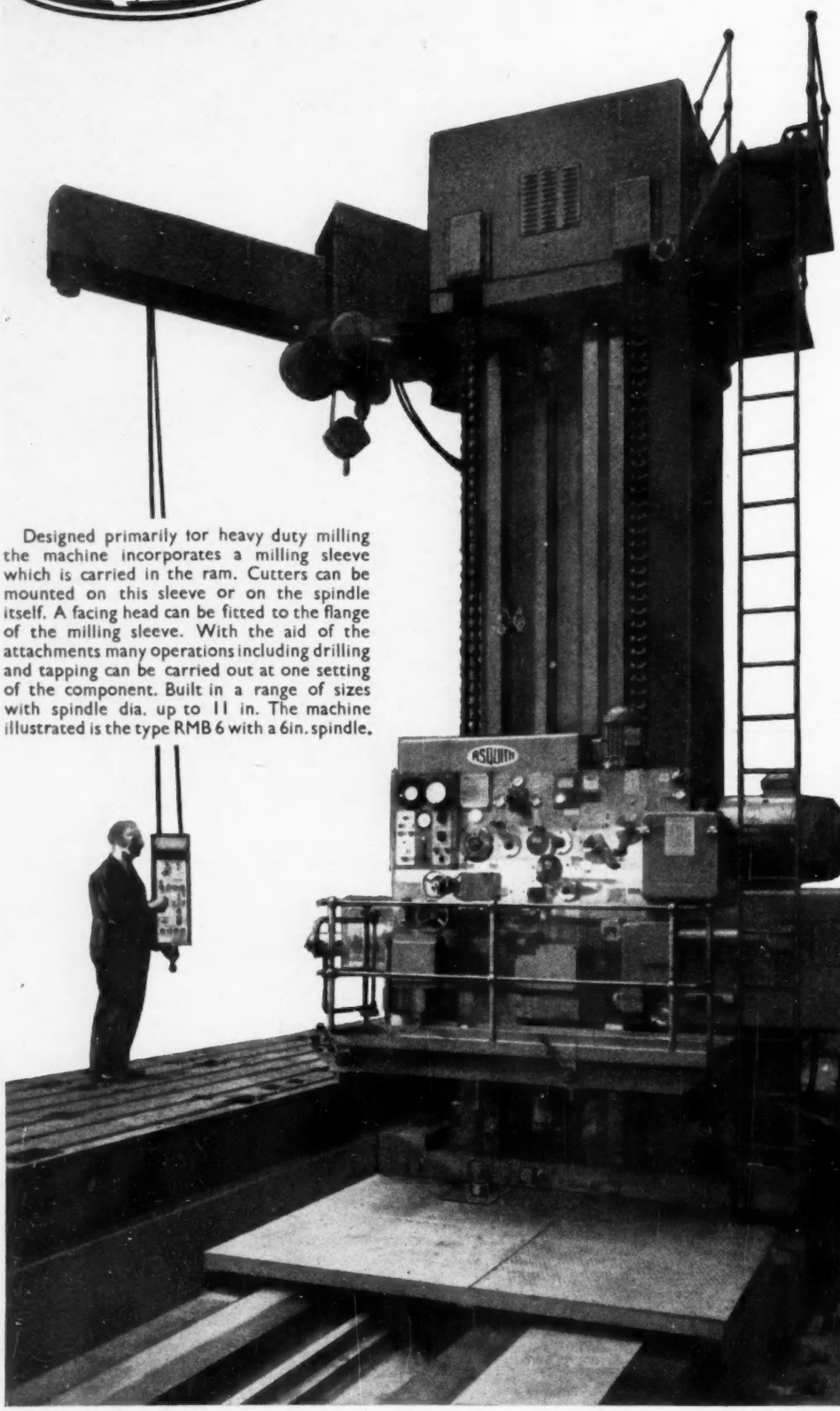
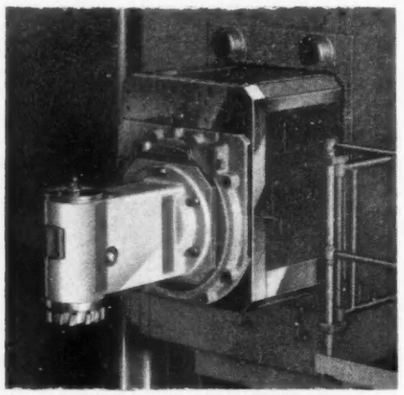
TGA TD166A

ASQUITH

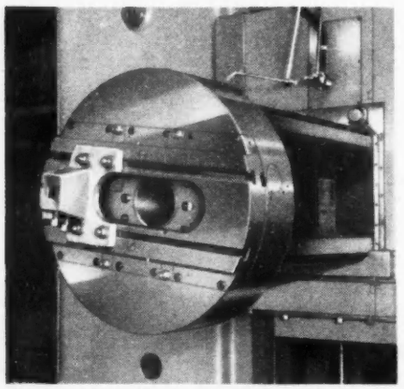
RAM TYPE Horizontal Milling & Boring Machine



Designed primarily for heavy duty milling the machine incorporates a milling sleeve which is carried in the ram. Cutters can be mounted on this sleeve or on the spindle itself. A facing head can be fitted to the flange of the milling sleeve. With the aid of the attachments many operations including drilling and tapping can be carried out at one setting of the component. Built in a range of sizes with spindle dia. up to 11 in. The machine illustrated is the type RMB 6 with a 6in. spindle.



Light type Right Angle Milling Attachment which is bolted to the face of the ram.



Surfacing Slide Attachment which is bolted to the flange of the milling sleeve.

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A410

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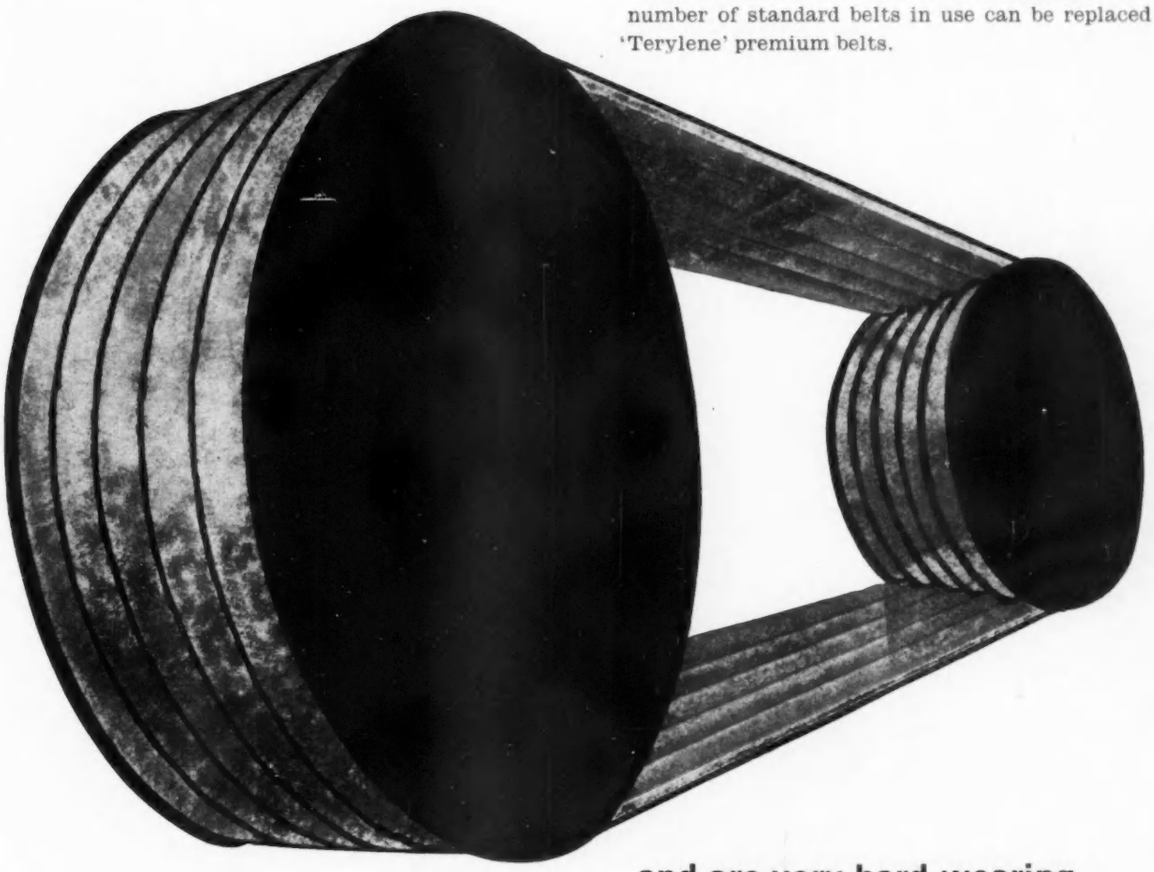

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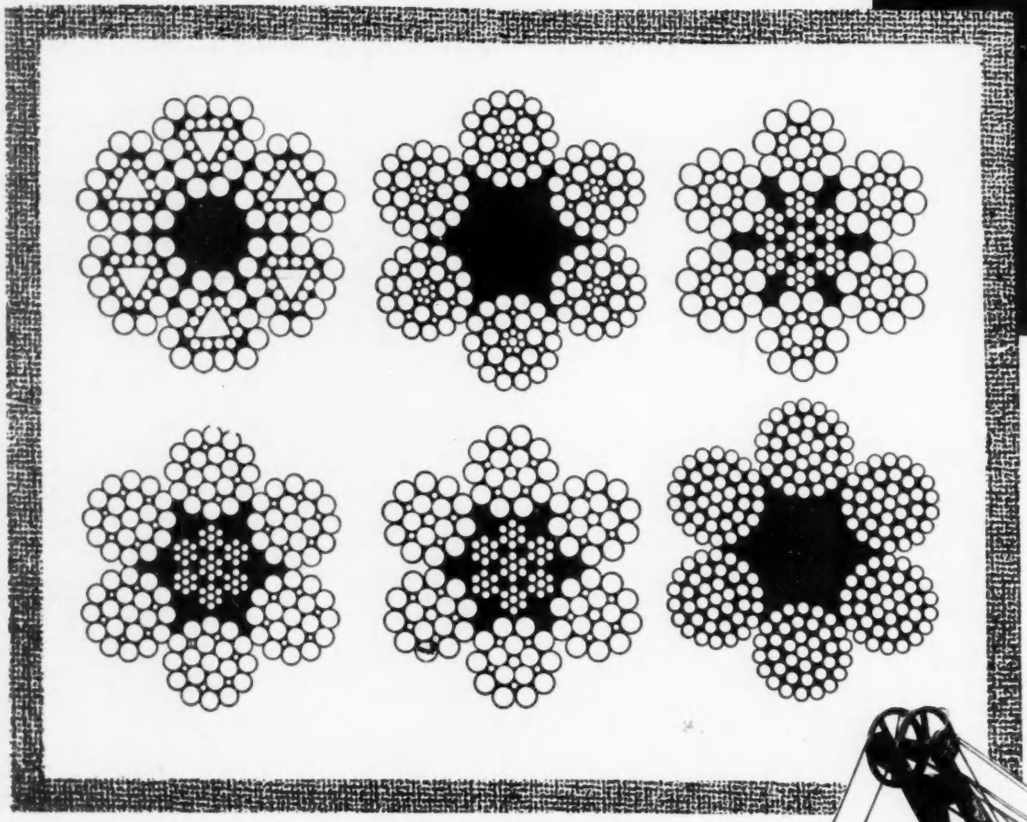

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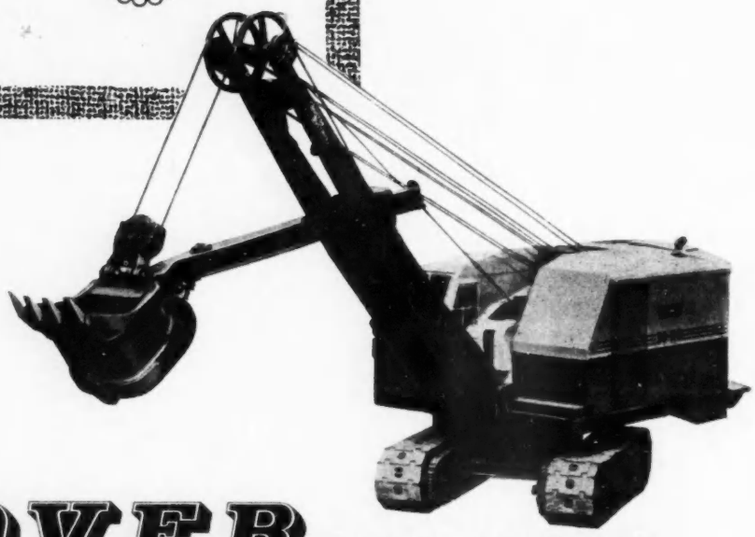

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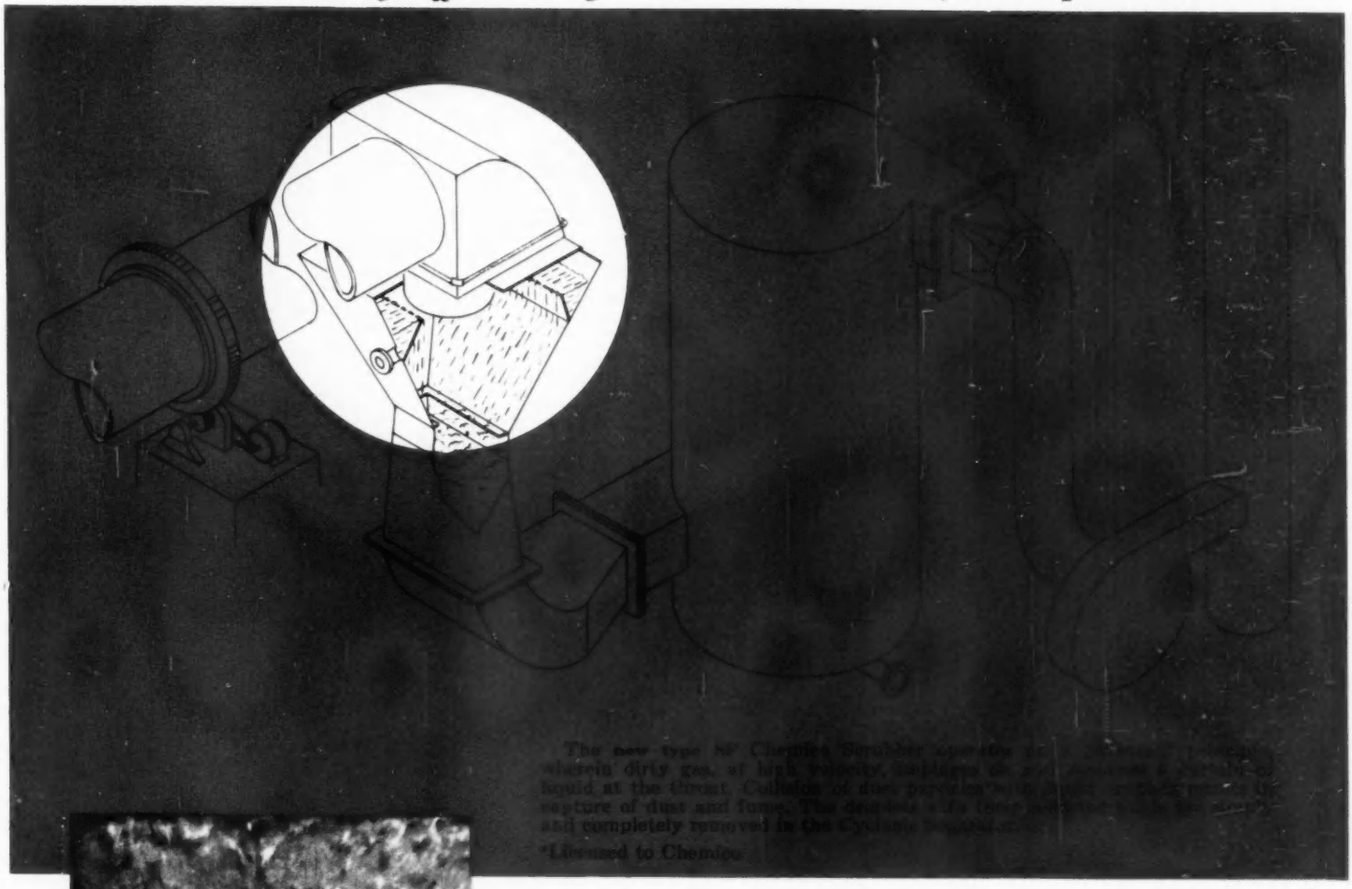
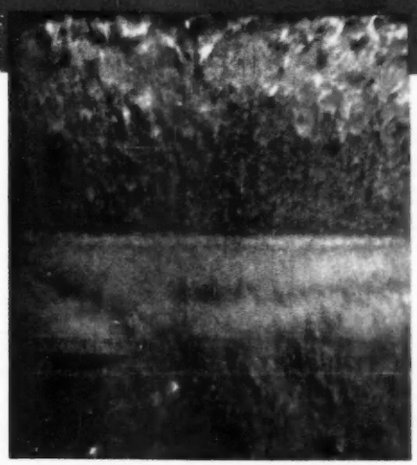
99% Scrubbing efficiency! Maintenance-free operation!





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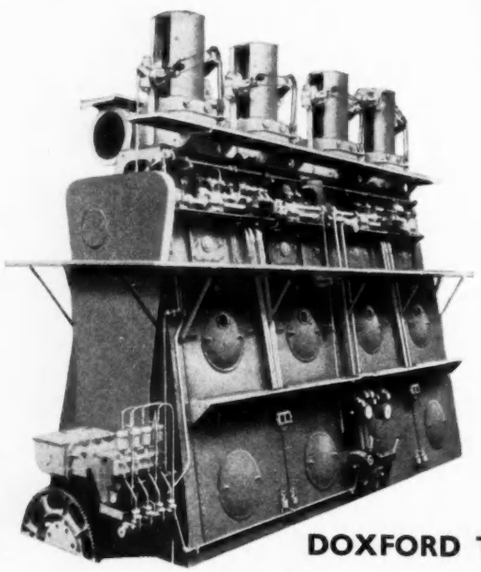
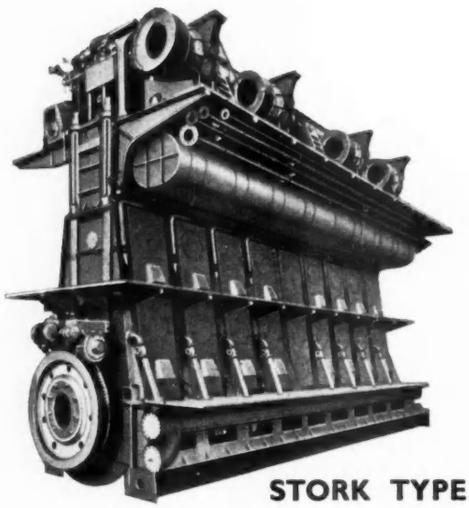


DOXFORD TYPE



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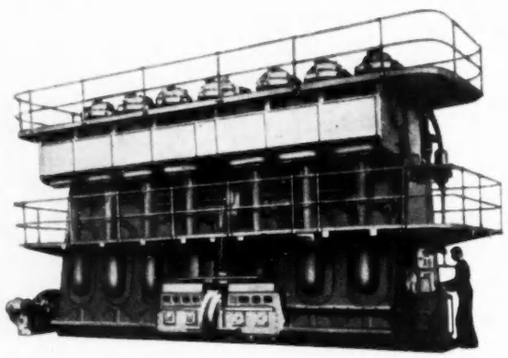

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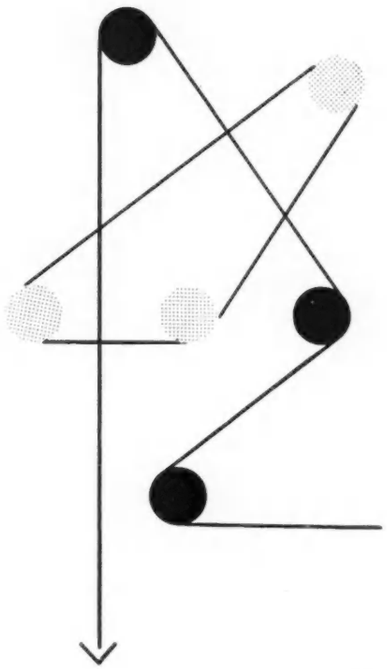

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roller bearings

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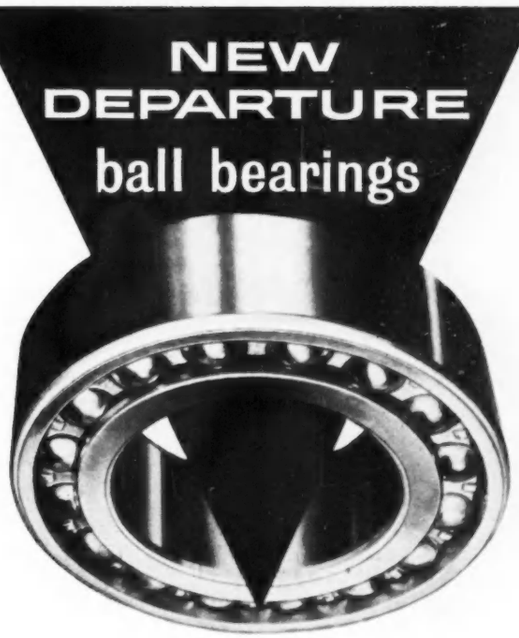

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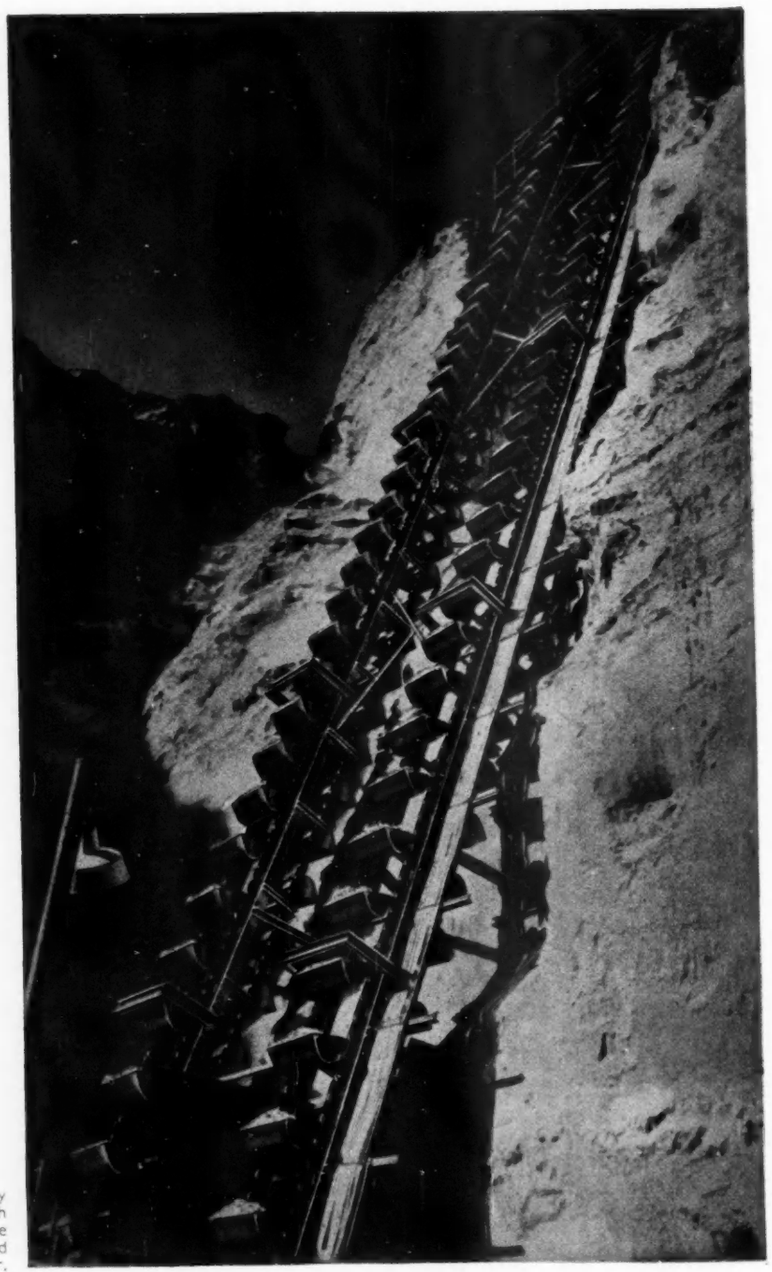
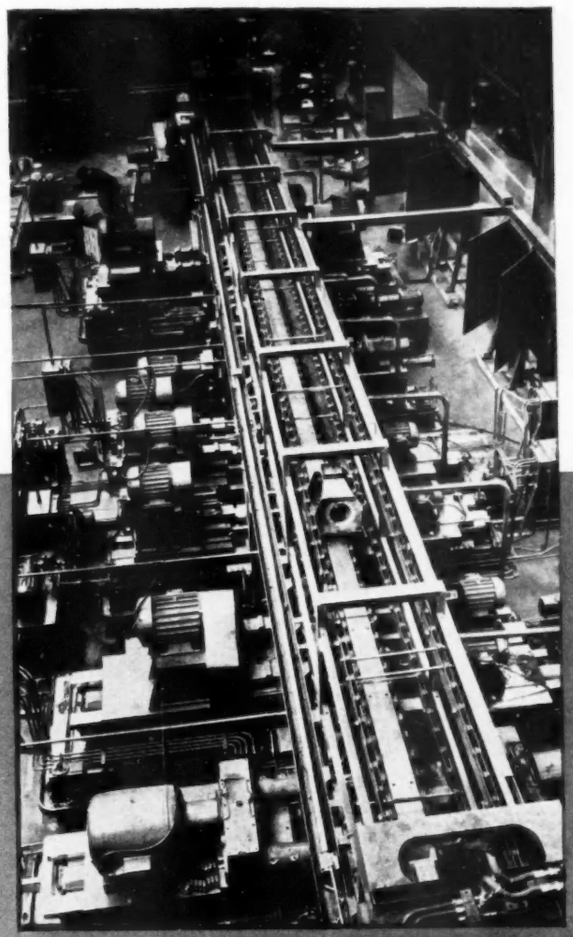


These two elevators in a Dutch quarry are equipped with Renold 6·0 in. pitch 30,000 lb. breaking load chain and are 82 feet high. They have a combined capacity of 220 tons of marl per hour.



Transfer machine for cylinder blocks employing two strands of Renold 6.0 in. pitch 12,000 lb. breaking load conveyor chain equipped with staybars.

90%

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Renold 3·0 in. pitch 6,000 lb. breaking load chain is used on this conveyorised assembly line, one of many applications in a modern factory mass producing clocks.

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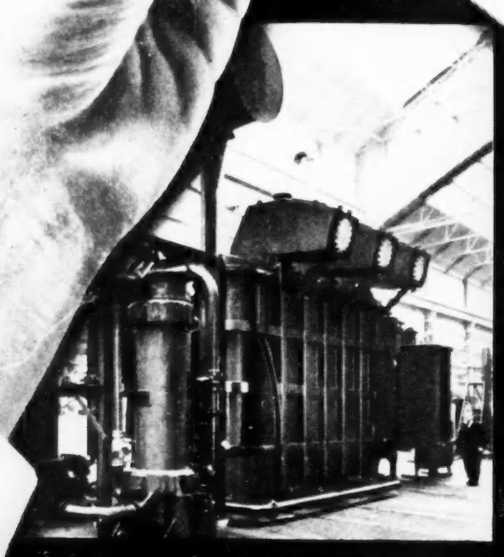

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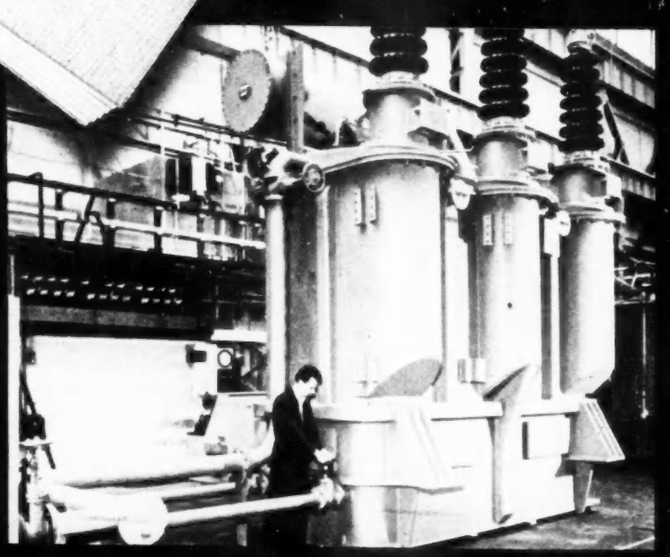

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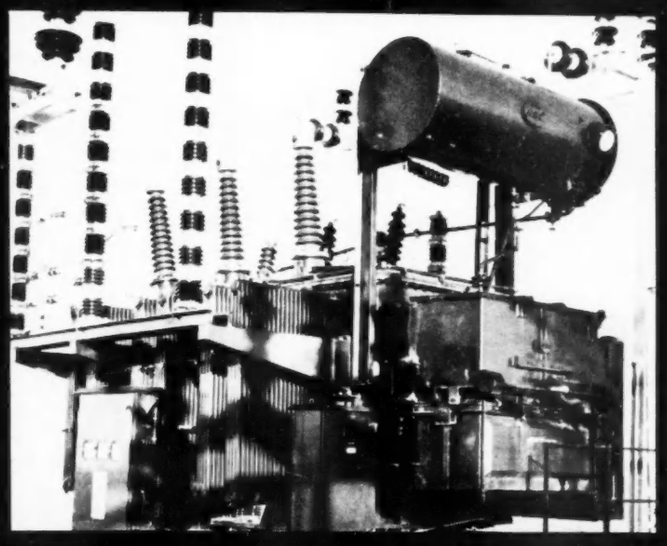

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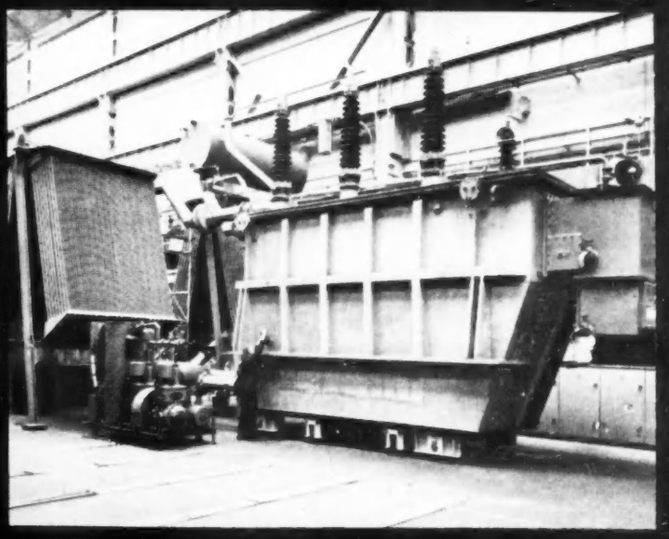

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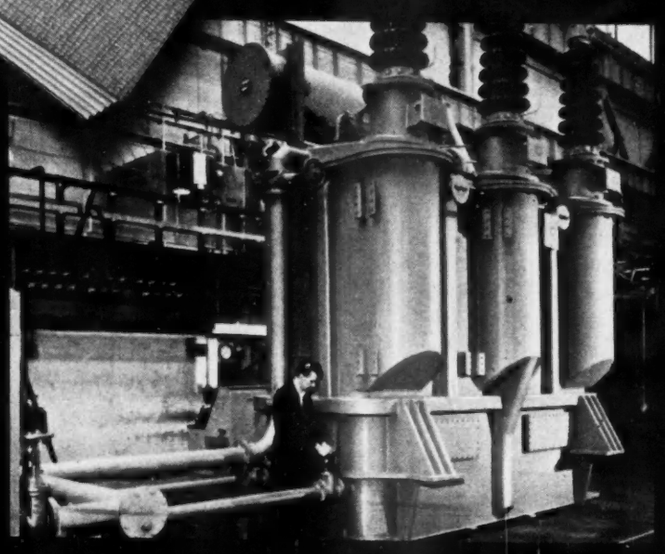

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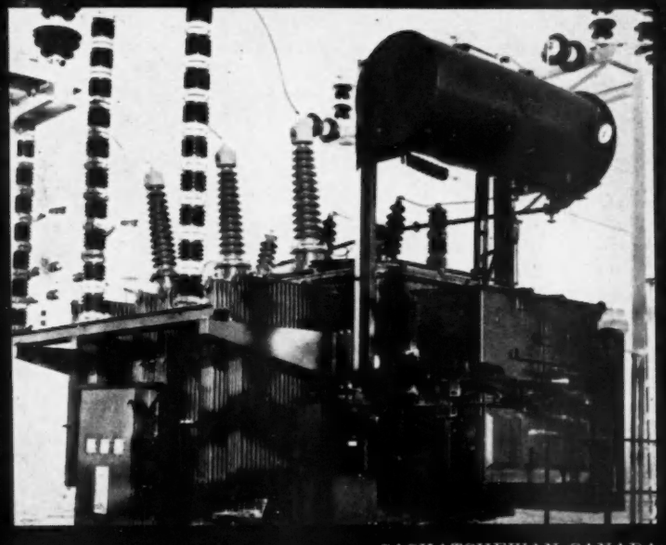

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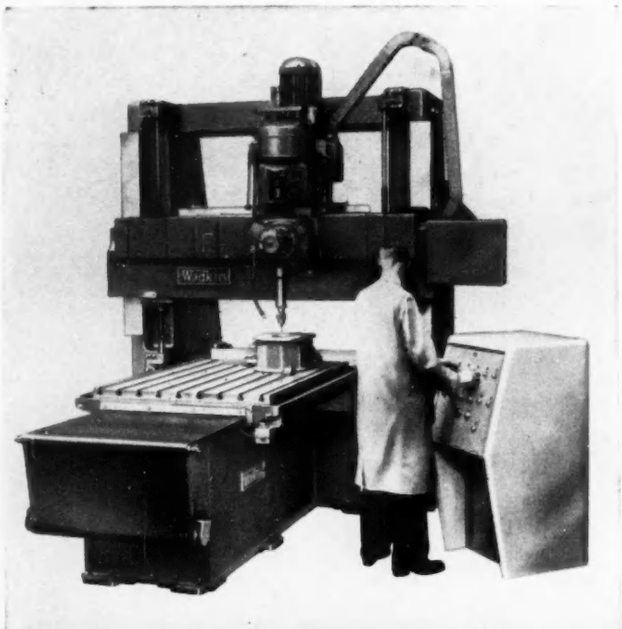

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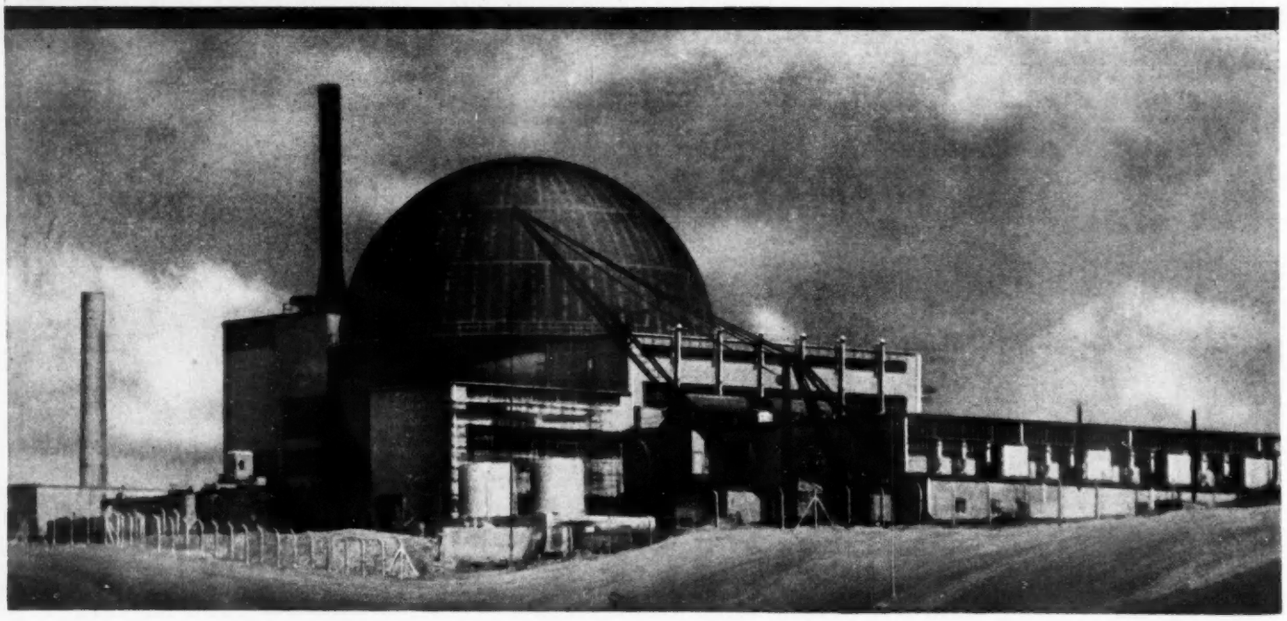
Most advanced of their kind —used throughout industry.



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Standard Shaft length ..... up to 20′
(Longer lengths can be supplied for specific applications)
Standard Pitches ..... 200″ 218″ 250″ 500″
(Non standard pitches can be supplied)
Shaft diameter ..... up to 4″
Life ..... 10,000,000 reversals
Temperature range ..... —90°C to + 100°C
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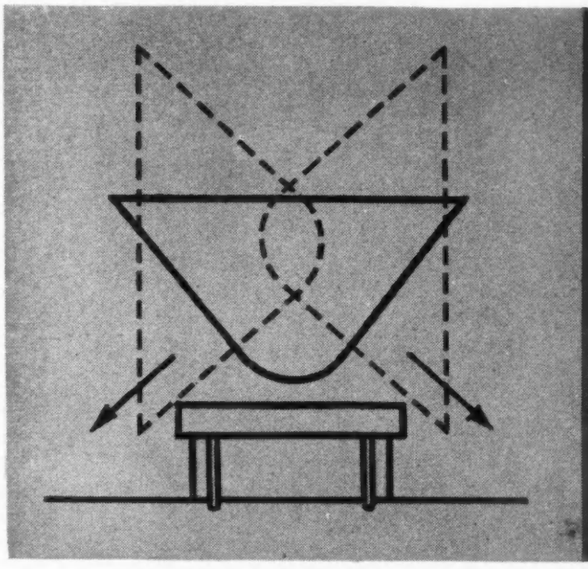
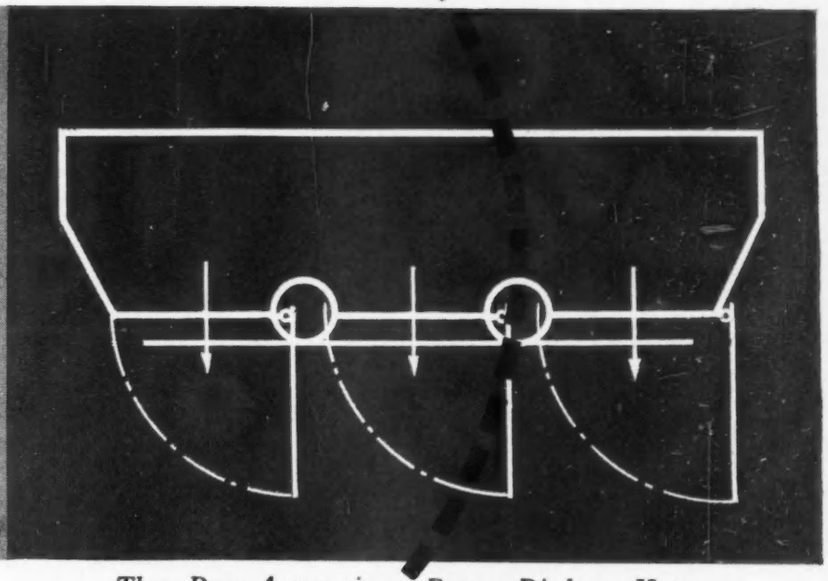
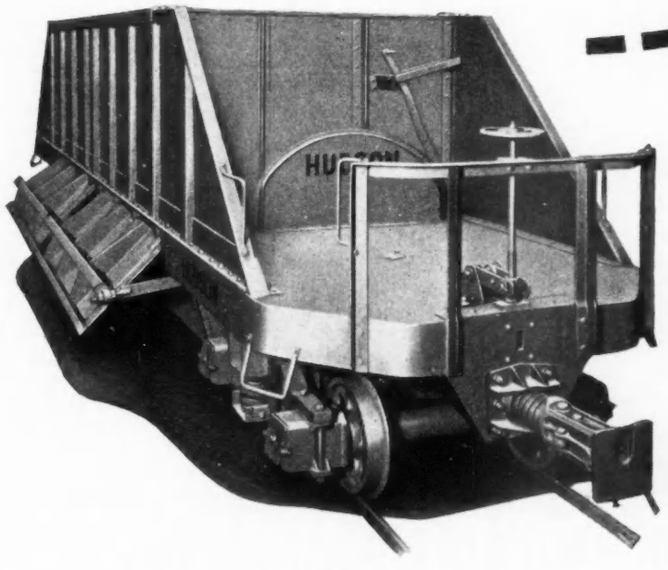


Double Side Tipping Wagon



Three Door Automatic Bottom Discharge Hopper

WITH SIDE AND BOTTOM HOPPERS



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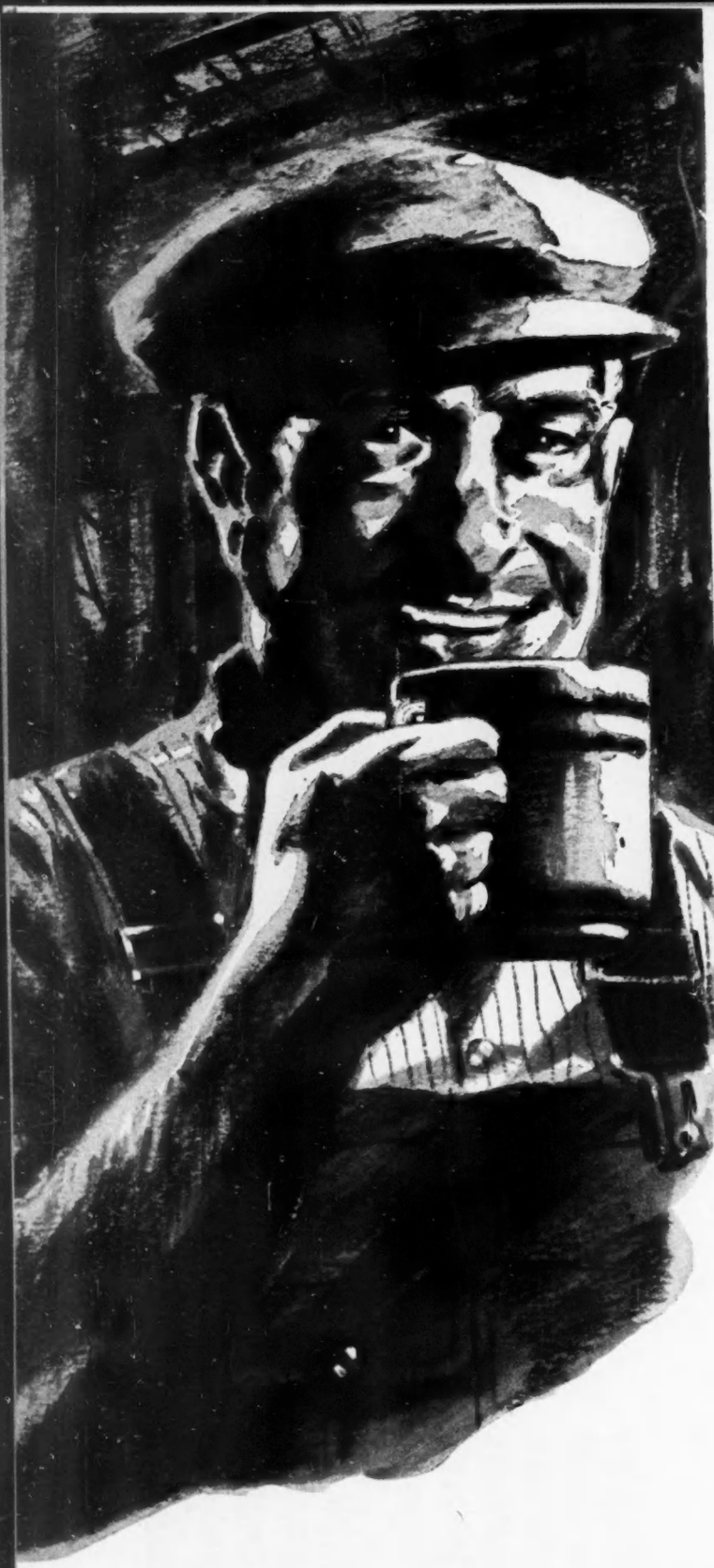
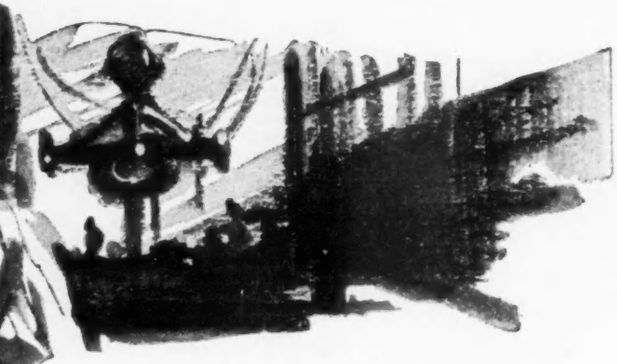


Helping to sweeten it is our cup of tea



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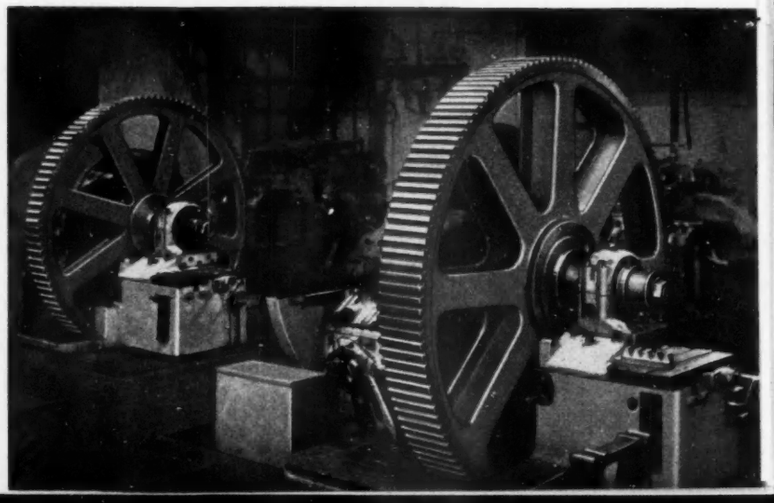

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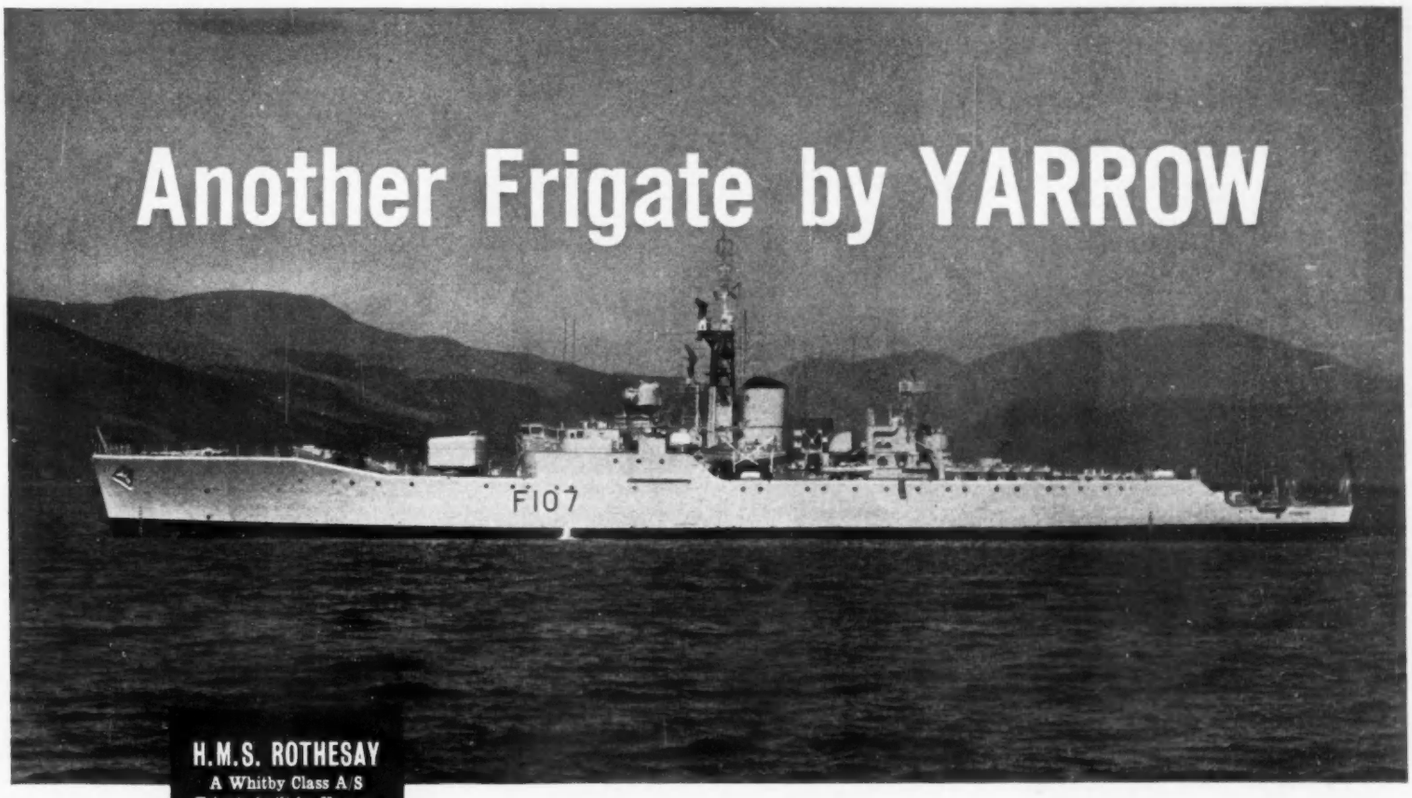

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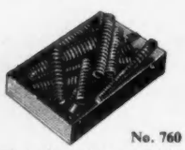

No. 760
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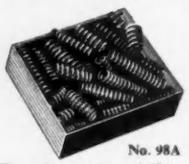

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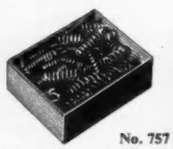
Three dozen Assorted 1" to 4" long, ½" to ¾" diam., 19G to 15G. 5/6.



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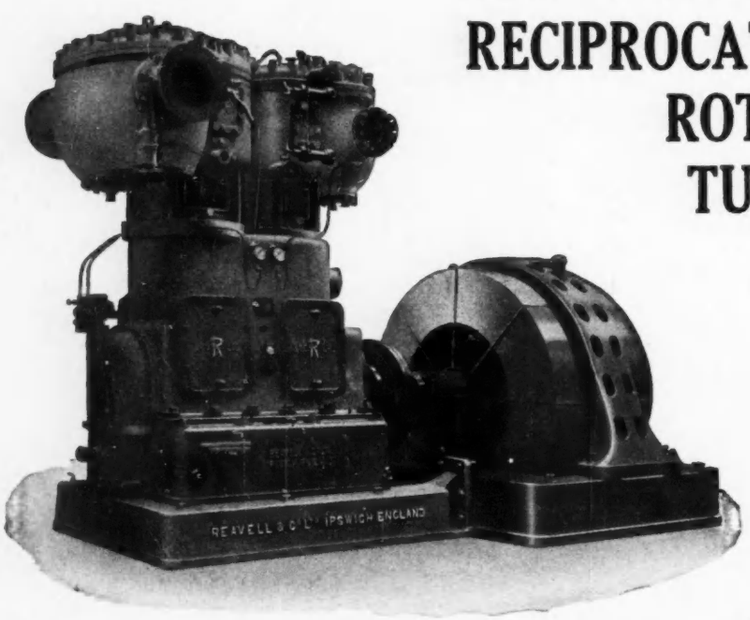

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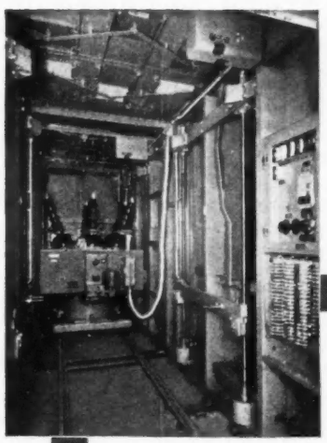

Above
A type UE1 33kV duplicate busbar switch unit showing the circuit-breaker in the rear busbar isolated position.

Right
A 14 panel single busbar type UE1 33kV switchboard.

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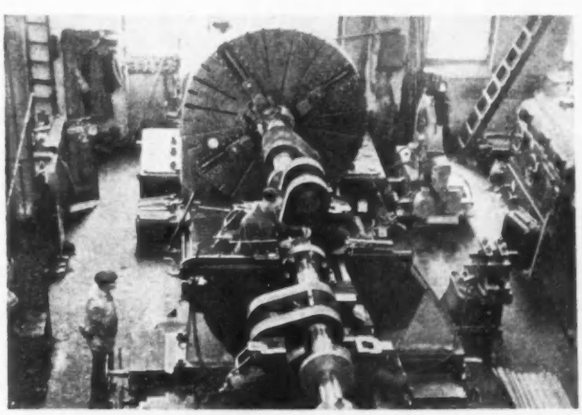

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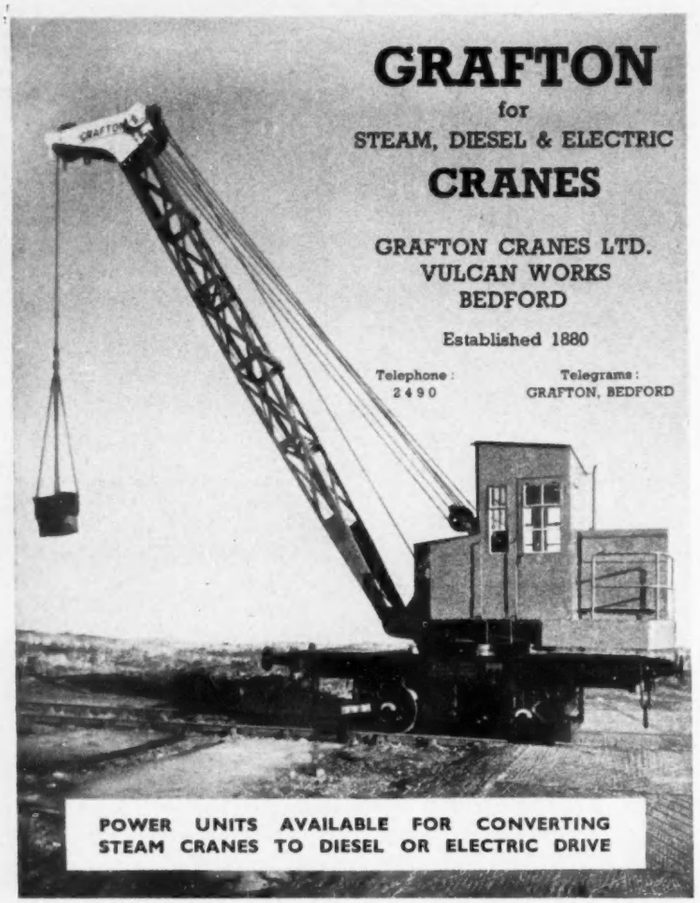

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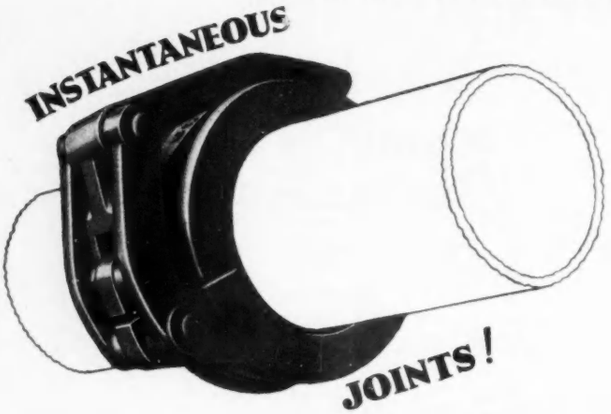

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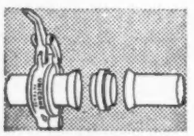
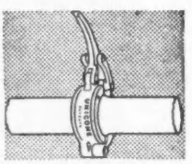
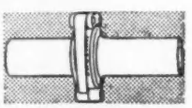

Rubber gasket in position and joint ready to pull over


Pipe ends joined ready for locking


The completed joint

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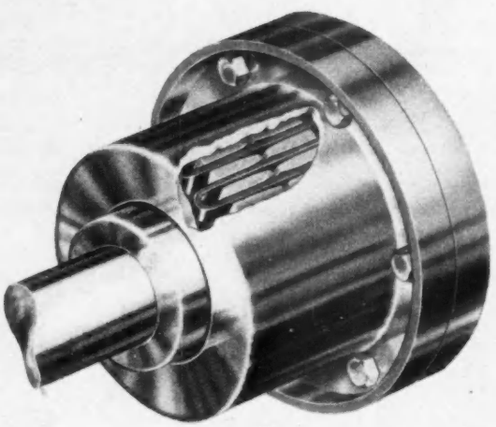

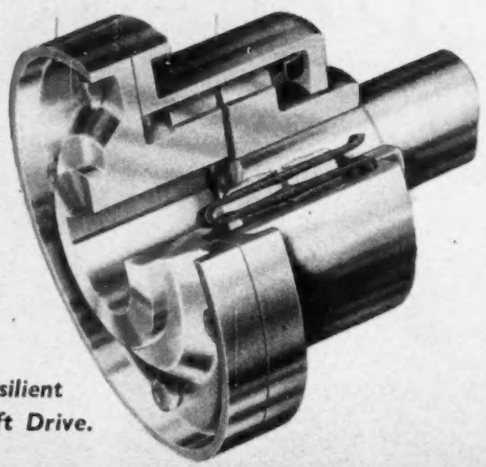

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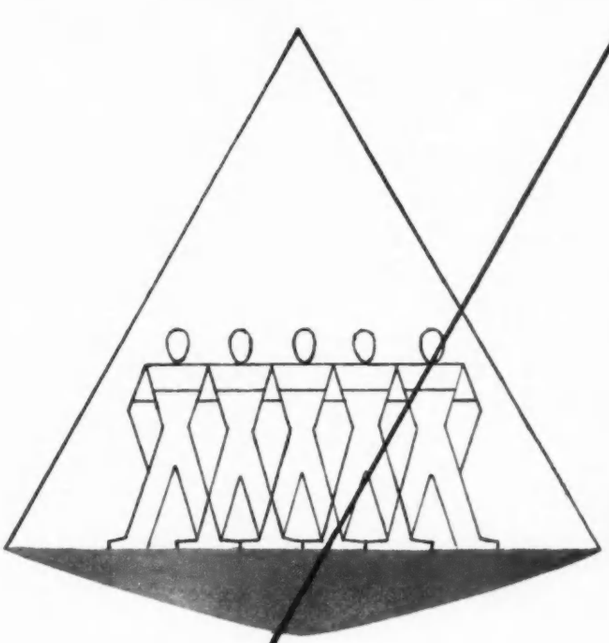

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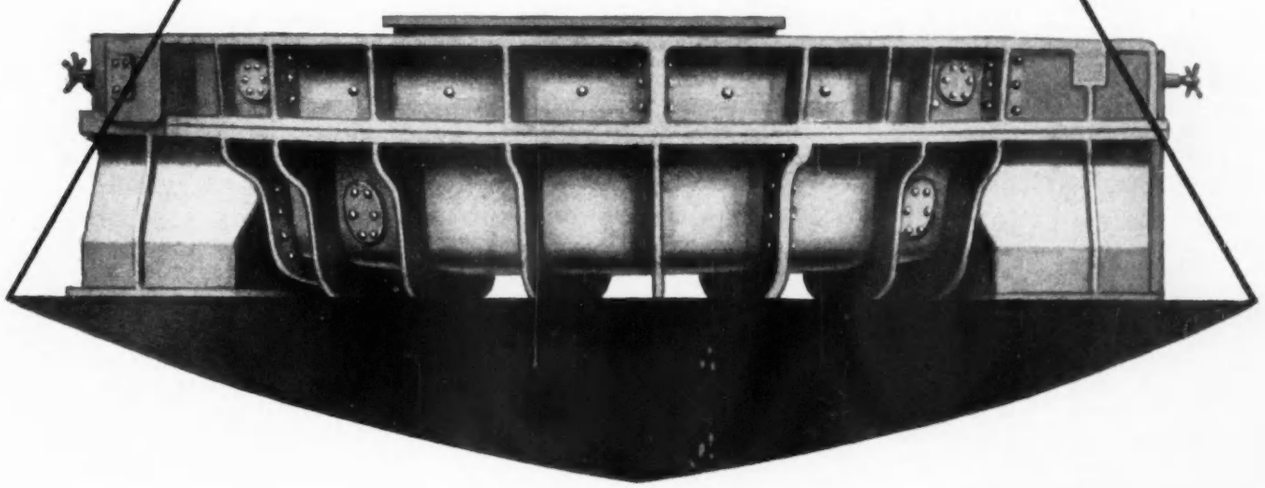

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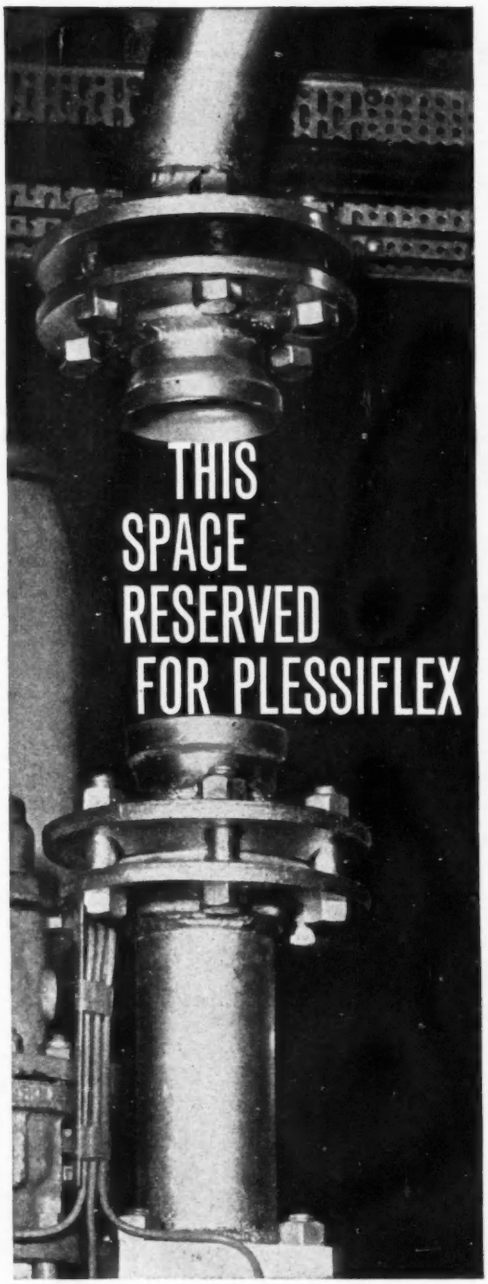

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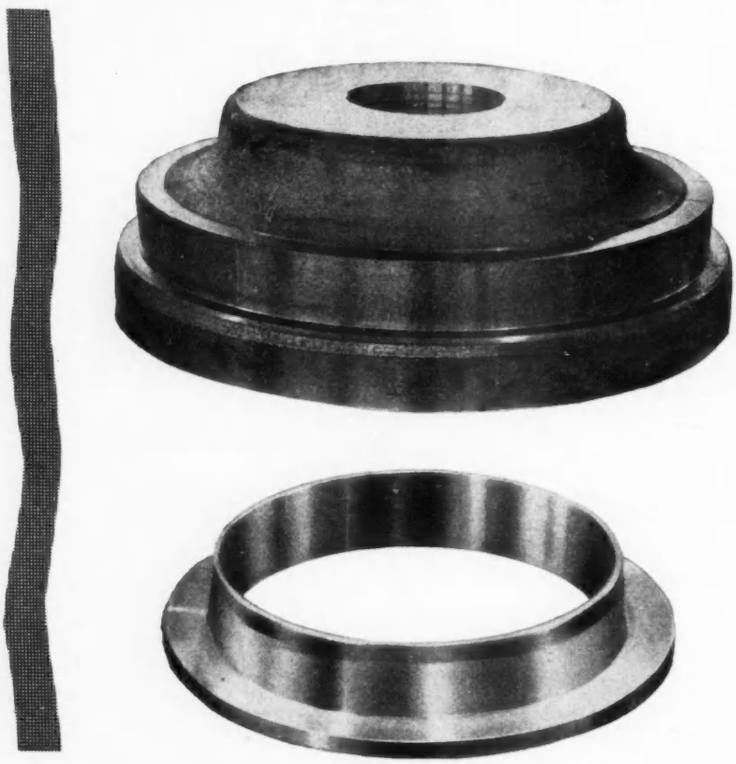

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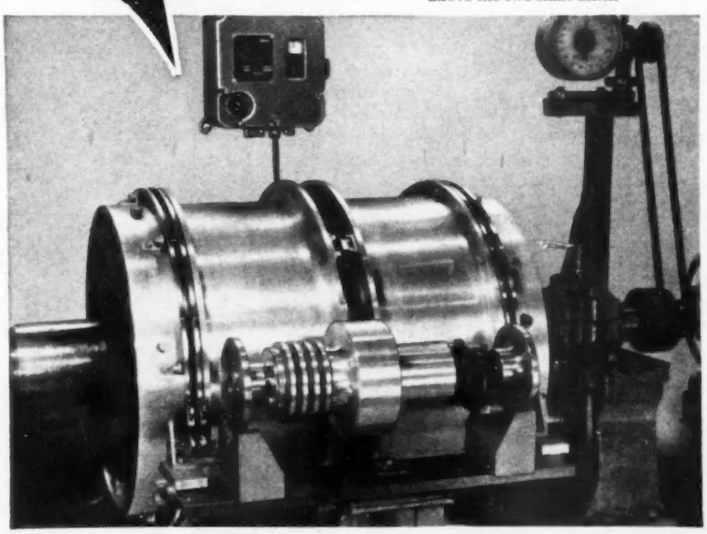

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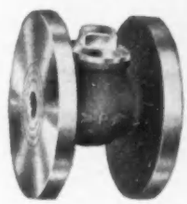

1043 FLANGED HORIZONTAL CHECK VALVE

Lifting type. Prong-type metal valves. Sizes ¼"-2". Flanged to BST 'E' as standard or BST 'F' on request.

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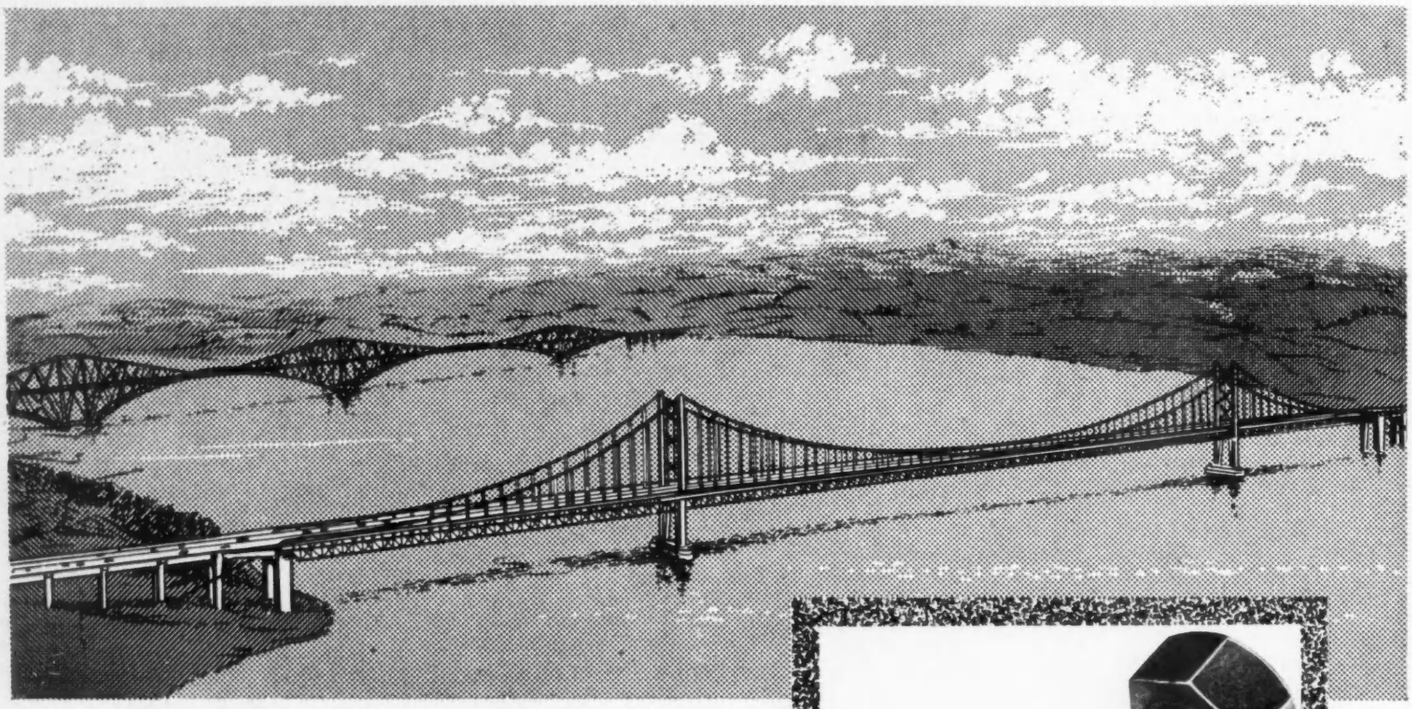

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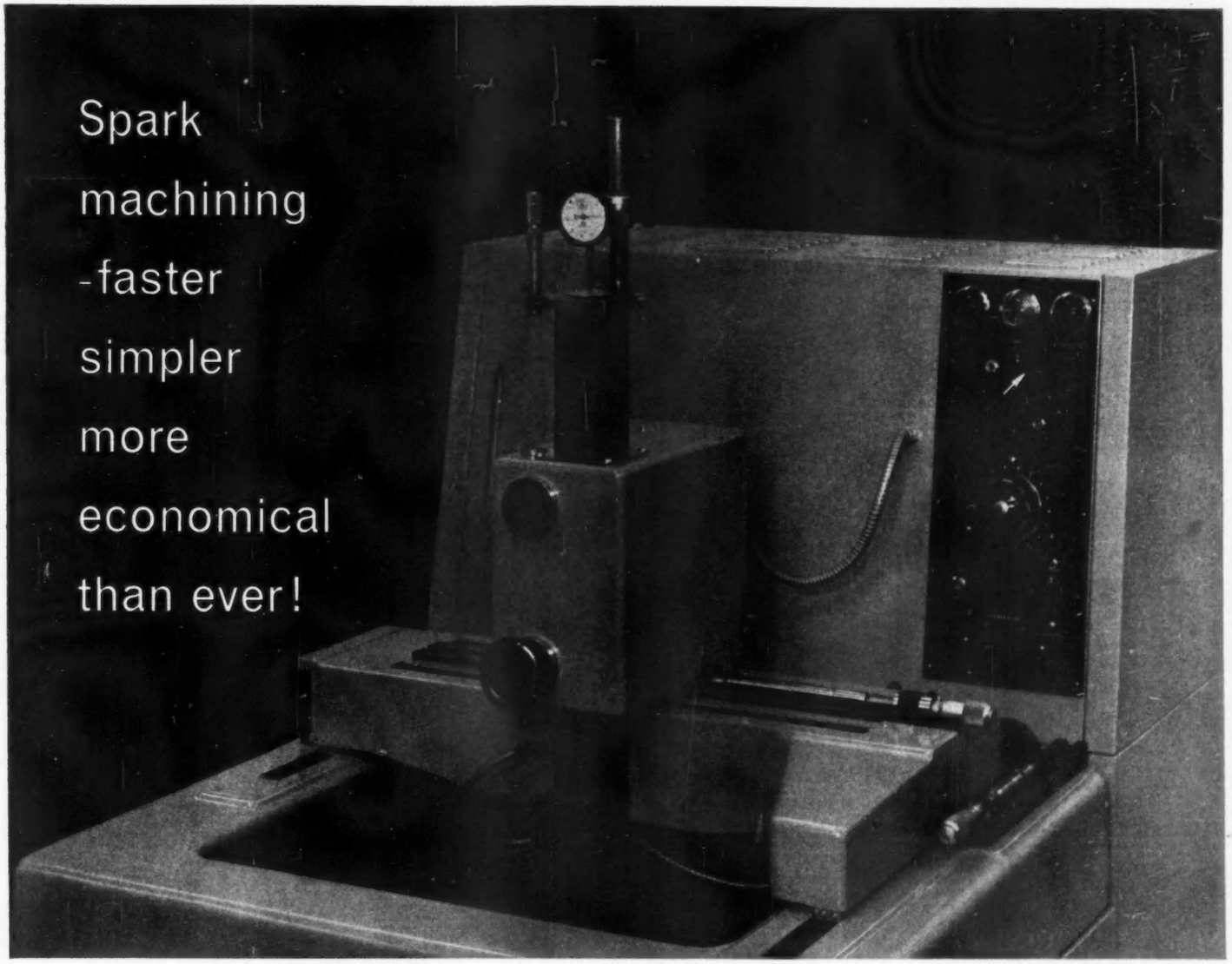
This allows the maximum tensile loading to be achieved, as the design removes the concentration of stresses from the thread roots to the shank of the bolt which can then be tightened into the plastic range with complete safety.



The GKN Spark Machine is faster, more accurate, more versatile

The GKN Spark Machine (Models B1 and B2) gives higher cutting rates, greater accuracy, and—on the B2 machine—a wider range of surface finishes than ever before.

It has all these outstanding features

These are some of the outstanding features of the GKN Spark Machine Models B1 and B2 :—

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It is compact and economical

The GKN Spark Machine is well-made, sturdy and compact. All parts of it—work head, electrical equipment and paraffin system—are mounted in the same cabinet. Yet with all these advantages, installation and running costs are low.

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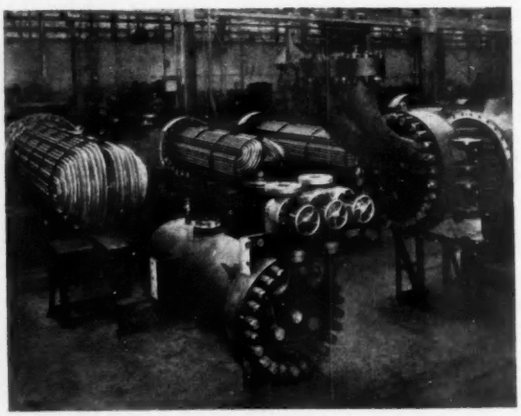
GKN spark machine

DESIGNED BY THE GKN GROUP RESEARCH LABORATORY

H&W

TUBES



H & W solid drawn copper tubes used in construction of Weir Marine Feed Water Heaters. (Photograph by courtesy of Messrs. G. & J. Weir Limited.)

Over forty years' experience in the manufacture of high quality non-ferrous tubes by the most scientific and up-to-date methods, and with a standard of workmanship and inspection of the highest order, have resulted in H & W Tubes being used by the leading shipbuilders and engineers.

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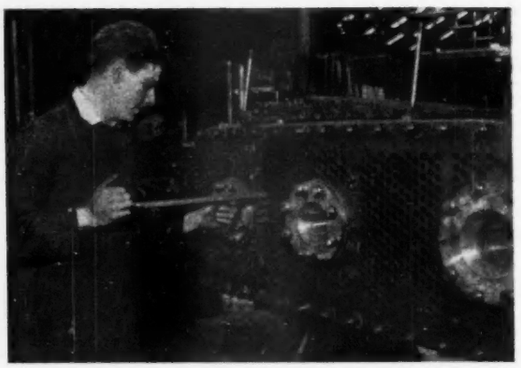
used by the leading shipbuilders and engineers



Fitting "Hudal" aluminium brass tubes in Weir Three-stage Air Ejector for the liner "Reina del Mar". (Photograph by courtesy of Messrs. G. & J. Weir Limited.)

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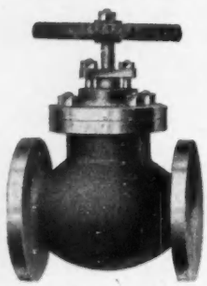

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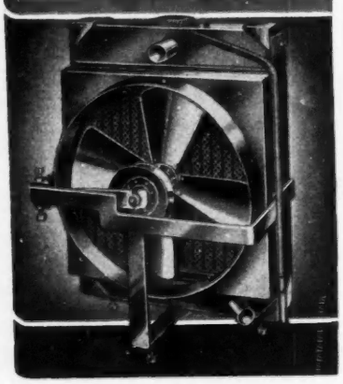

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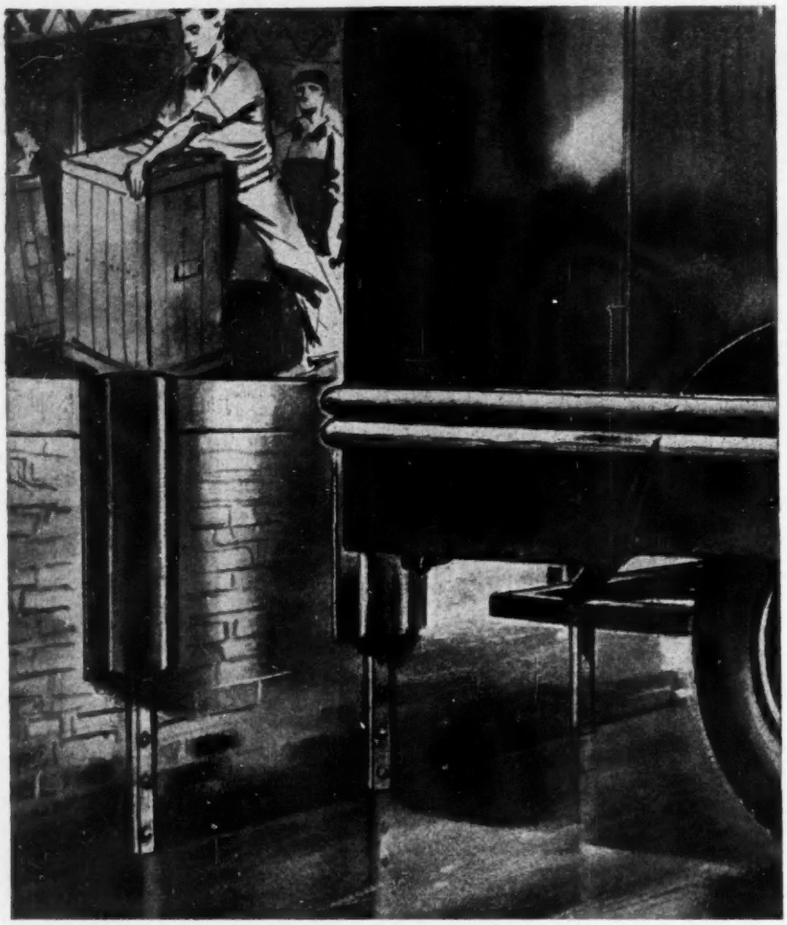

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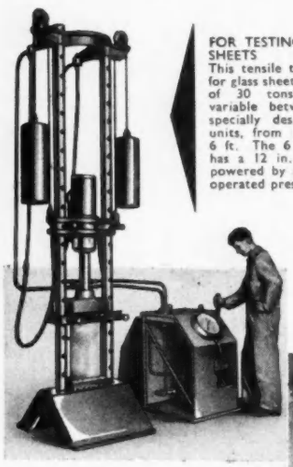
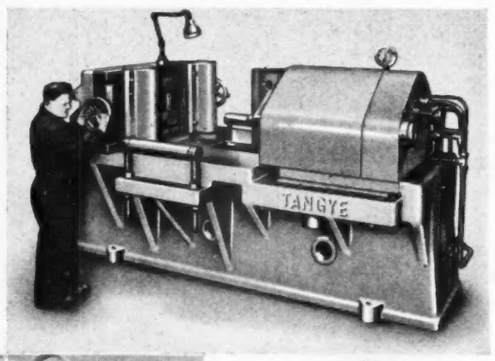
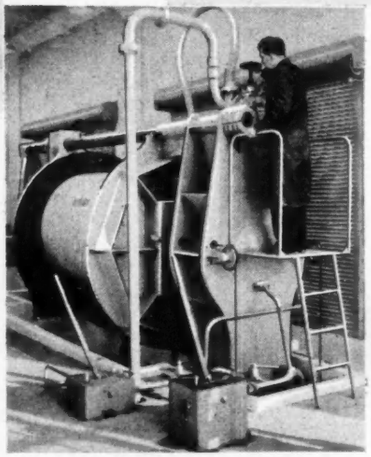


FOR TESTING GLASS SHEETS
This tensile testing machine for glass sheets has a capacity of 30 tons. Daylight is variable between the two specially designed gripping units, from 1¼ in. to over 6 ft. The 6 in. diam. ram has a 12 in. stroke and is powered by a Tangye hand-operated pressure pump.





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Large pipes to be pressure tested are clamped between two rubber-faced plates and are filled with water by either a gravitation feed or by a Tangye centrifugal pump. Pressure build-up is then achieved by a Tangye hydraulic hand pump. The above view is reproduced by kind permission of Norcon Ltd., in whose test house Tangye equipment is well in evidence.

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ENGINEERING Impact

of Science in American Industry

THE USE to which a community puts its skilled scientific and engineering manpower is a growth factor of an advanced economy. The American National Science Foundation has recently published an account of the use made of these categories by United States industry.

In the three years 1953 to 1956 the amount spent on research and development by industry in the US went up from $3·5 to $6·2 billion. The main cause of this increase was the greater number of Federal Government contracts. The aircraft industry was the chief spender disbursing twice as much as any other industry in 1956. Second came the electrical equipment industry and these two together accounted for half of all industries' spending, and it should be noted that the aircraft category includes the entire long range ballistic missile programme which was in the research and development stage back in 1956. Machinery, chemicals, and professional and scientific instruments filled the next three places. These spend $600, $450 and $200 billion respectively.

Federal Support

Not all chemical and electronic research is covered in the industrial breakdown, for the survey showed that companies outside these two industries carried out research within these fields. Nevertheless, the amount shown to be spent on electronics was about $1·2 billion and on chemicals about $715 million. Three industries—textiles, construction and transport and other public utilities—showed a drop in research and development spending between 1953 and 1956.

One of the most interesting aspects of the general pattern of spending is the share borne by the Federal Government. In the aircraft industry 87·2 per cent of research and development expenditure in 1956 was government financed. In electrical equipment the proportion was 56·4 per cent, telecommunications and broadcasting 43·3 per cent and machinery 41·3 per cent. In two others —fabricated metal products and ordnance and professional and scientific instruments—it accounts for around a quarter of the money spent. Elsewhere federal participation is negligible. Even so, in 1956 it accounted for 47·6 per cent of research and development work, representing an advance of 10 per cent since 1953.

Research and Prototypes for US Firms

Spending by firms covered by the NSF survey mentioned in the note above was very much a matter of size. The big companies with over 5,000 employees covered 80 per cent of the research and development spending by private industries. The NSF inquiry tried to find out what part of industries' research and development budget was for basic research with no specific production objectives. The answer was about 4 per cent, representing some $244 million. The industries spending most on research were those, like the aircraft industry, involved in building expensive prototypes and models. Above-average basic research investment was also found in the chemical industry and for electrical equipment.

How many people were required to carry out this very considerable programme of research and development? Altogether 728,000 scientists and engineers were employed in industry when the NSF survey was taken in January, 1957. Of these 521,000 were engineers 71,000 chemists and 136,000 were other scientists. A further 59,000 scientists and engineers were engaged in jobs that were administrative rather than scientific. The total number of engineers and scientists engaged in research and development was about 223,000, representing an increase of 40 per cent since 1953 and it was noted that all the major occupational groups had shared in this expansion. The biggest increase was in mathematicians who had shot up by nearly 66 per cent, reflecting the growing number of jobs connected with electronic computers. Engineers increased by 46 per cent, physicists by 44 per cent and metallurgists by 25 per cent.

How much did companies spend on research and development? The survey takes firms with over 1,000 empooyes and shows their spending on research and development as a percentage of sales. Scientific instruments (3·7 per cent) and electrical equipment (3·2 per cent) come out on top. The average for all industries is 1·3 per cent. Other industries with above average spending are chemicals, machinery, and aircraft.

The NSF survey is part of a programme of studies begun in 1954 covering scientific activities in various sectors of the economy. National temperature-taking on this scale is an extremely useful operation.

Long and Short Term Investment in Science

While the debate goes on whether to Streak or not to Streak into the blue fringes of space, there remains unexplored an exciting frontier that requires no orbiting.

Seventy per cent of the earth is covered by water, yet less is known about the oceans than the accumulated scientific knowledge on the least inhabited continents of the earth.

Expenditure on space research acts like a shot of adrenalin on certain sections of the engineering industry. It results in feverish activity and produces a burst of knowledge that can be widely applied.

But expenditure on oceanography would have the effects of a steady diet; it would influence the supply side of the engineering industries more profoundly than the design capability. The oceans contain the largest untapped resources of food, raw materials and energy, provide communication between the continents, and control the climate to a large extent through the movement of ocean currents.

Manpower and money are the keys to research, both of which are lacking for oceanography. There is an urgent need for a comprehensive ocean-going research ship that can remain at sea for months at a time and undertake a wide range of research topics simultaneously. Manpower is another acute problem, and Unseco is now sponsoring the setting up of fellowships and scholarships to remove this bottleneck. Ultimately the money must come from the Governments' scientific budgets, and ability to earn concrete as well as political returns must weigh heavily. Oceanography has every promise of being a profitable venture.

of Footing the Bill for Development

Who should play the dominant role in developing new designs—maker or user? This is a question that keeps cropping up in various guises and in widely dissimilar industries.

Should the machine tool maker, for example, take care that he collects enough profits from his customers to plough back into the development of improved and inevitably expensive designs? Or should a wealthy user, who knows with so much more precision what will be wanted in the future, set about developing a prototype himself? He can then come to some arrangement with a maker to go into production with the finished design.

The new chairman of British Overseas Airways Corporation, Rear-Admiral Sir Matthew Slattery, is anxious about the need to press on with the development of a supersonic airliner. BOAC, he says, promise every possible support short of any economic commitment for aircraft. Who will find the money? Presumably the Government.

Dr. H. Motz, of Oxford University's engineering laboratory, has found that he cannot interest a leading maker of telephone equipment in the possibilities of long-distance microwave telephony. One reason, he thinks, is that Post Office contracts are given to a group of old established firms, and contracts for components of any new system which might be developed by one of the firms are always distributed evenly to the other companies.

The process industries which sell large quantities of small packets of their products can afford to develop their plant and equipment by simply allocating a fraction of a penny from the sale of each packet.

But the capital goods industries are in a difficult position. For neither the maker nor the user is it easy to finance long-term design development.

Neglecting Science in Secondary Modern Schools

The cynic may say that the appalling state of science teaching in secondary modern schools is neither here nor there for the grammar schools will provide enough future scientists for our needs.

True or false this misses the point.

In the classrooms of these schools will be a small percentage to whom the selection has for some particular reason of temperament or health been unfair. As a nation we cannot afford to throw away future careers of men who may have as much to give as Sir George Edwards or Lord Hives.

And to turn from the minority to the great mass of the secondary modern schools "old boys": in factory, office and home these are going to be the average people, the popular newspaper reader and elector of governments in an increasingly technical age.

Living in an age they do not understand, surrounded by devices they do not comprehend, these basically uneducated citizens of 1965 and on will be about as much help as a 19th century dandy at Calder Hall.

The survey conducted by the Science Masters' Association showed that at 73 schools there was no science teaching because of lack of facilities, at another 33 none because there were no teachers capable of teaching science. The same modesty did not hold back a sixth of those who do teach science in secondary modern schools. These had no "pretensions to scientific qualifications." Only one science teacher in six was a graduate.

With industry moving towards greater control of its production by machines it could be thought that the education of the majority is not as important as the teachers' organisations and leaders proclaim. But in a competitive world we are not free to flirt with this unpopular idea.

The United States, Germany, and to the furthest extent, the USSR, are all training more scientists, proportionally to their numbers than the UK.

The great advances in engineering or any other field of human endeavour have begun in the mind. If this particular form of neglect continues it will need no great education to feel the consequences.

and Sale and Exchange of Engineering Ability

Diversification, the not-so-easily trodden pathway to industrial expansion, demands more than anything else a widening field of specialised knowledge: "far more than can be relied upon to be forthcoming from the development and research effort of a particular group.

More and more the answer is found to lie in the introduction of manufacturing processes from outside, often from the United States or Europe.

If manufacture under licence has been the key that opens the door for the medium sized engineering concern, enabling it to move up into the large-scale operations, it is now beginning to look as if manufacture under licence has an important future in modifying the effects on world trade of the political power blocs and the contending European trading areas.

Licencing arrangements between the United States and Britain, by which more money goes East into dollars than travels West into sterling, shows that, with the Commonwealth, the United Kingdom does proportionately better out of these arrangements with the US than other nations. This is a field where the return is directly related to the success of the particular nation's development of its engineering industries. Licencing agreements are not only drawn up with a view to royalties. Interchange of licences enables both parties to extend the field of their activities. Such agreements could make a great deal of difference in the speed of development of the less industrialised members of the European Free Trade Association.

Their importance serves to underline the significance, indirect as well as immediate, of the swift exploitation of research and the implementation of new ideas throughout firms of all sizes.

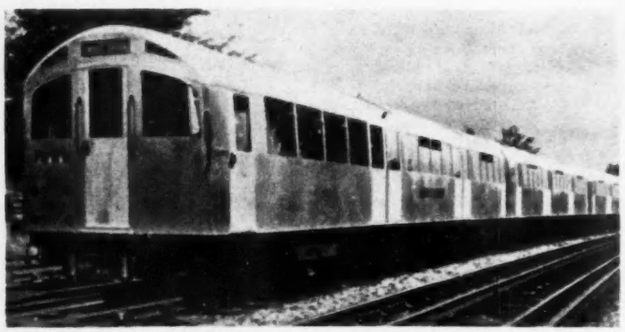
Gaining Confidence in Rubber Suspensions

The amount of rubber in cars and rail transport will increase steadily in the next decade. It is the natural answer to noise. But don't think that its use requires little thought.

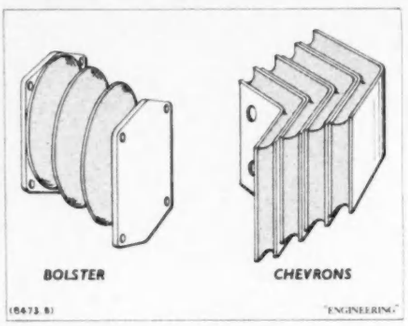
Rubber for vehicle suspensions is entering a period of public and technical confidence. Probably the most important contributors to this were the BMC " babies " whose rubber suspensions were given as much publicity as the other revolutionary features of the design.

It may seem wrong to lump air suspensions in with solid systems, but so far as the destiny of rubber is concerned these examples point to just a few of the many uses to which it could be put. Perhaps the one lesson to be learnt from these examples is that the days of the leaf spring are numbered and that there are many exciting possibilities for new systems. Our large vehicle engineering industries can surely get to grips with the standardisation, specification and maintenance problems of, say, half a dozen new ideas.

Rubber, of course, is intermediate between steel and air: it has high compressibility, i.e. bulk modulus, but has low shear modulus. It also has the characteristic not shown to a large extent by the other two materials of absorbing energy at high frequencies, and of setting under strain. One must consider, therefore, the effect on component location, and retention of spring rate and hysterisis under temperature fluctuation. Few of these militate against use of rubber, and graduation of this material from an odd job man to a major suspension material is welcomed.



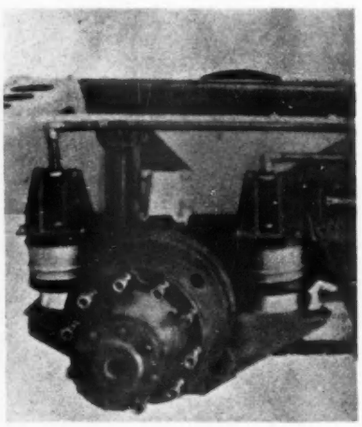
Bolster and Axlebox Springs for LTE

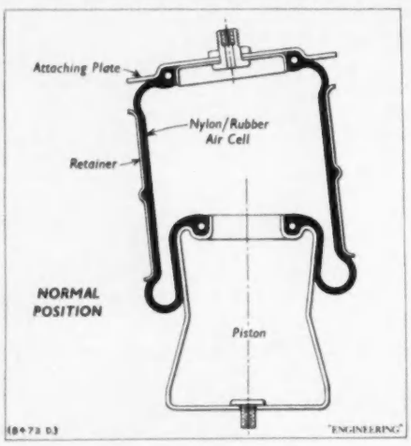


The decision of the London Transport Executive to fit all-rubber suspensions on the aluminium rolling stock for the Piccadilly line was based on experience extending well over ten years. Metalastik developed both bolster and axle units for them.

There are four bolster springs of the type shown for each bogie and these are arranged in pairs in an inverted V arrangement. By this means the desirable condition of maximum stiffness parallel to the rail is obtained.

Rubber axlebox springs obviate the wear problems of greased manganese-steel liners. They are fitted in pairs and their four-chevron design absorbs rail joint vibration with high fore and aft stiffness.





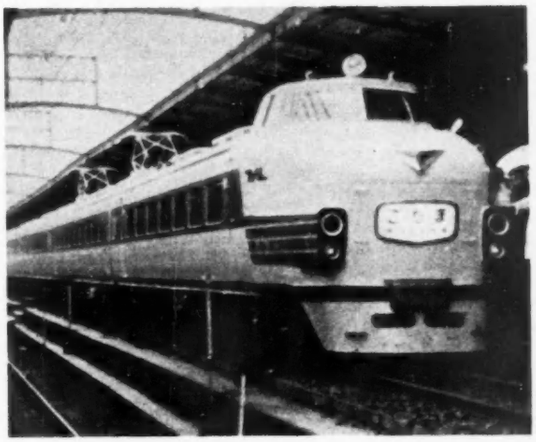
Australian Diaphragm Air Suspension

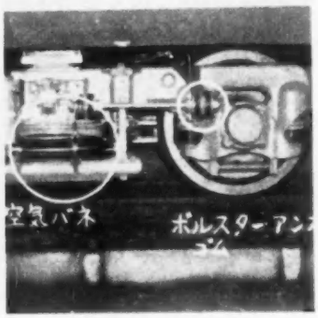
Air springs are now fitted to the 60 passenger coaches owned by Ansett Transport Industries in Australia. They are a combination of imported and Australian manufacture. Neoprene (the oil resisting synthetic rubber made by Du Pont) and nylon cord air bags, and the height control units, were imported from America. Shock absorbers came from Armstrongs in England, and the metal containers and natural rubber joint bushings were Australian.

The design, shown in its normal position, allows jounce and rebound by rolling of the diaphragm. Unlike the Dunlop Pneuride suspension which is being widely tested in the United Kingdom, this does not normally require a large reservoir of air for each unit. But it gives similar natural frequencies of 80 to 90 cycles a minute. Constant height under all conditions of loading is controlled automatically in both systems by a levelling valve which allows more air from a compressor to enter the springs when heavy loading tends to depress the chassis. There has, of course, to be a delay-device so that normal movements of short duration do not operate these air valves.

The characteristic of constant height, which is unique to pneumatic suspensions, is particularly suited to transport vehicles such as single and double-decker buses. Moreover, the fitting of air bellows where there is limited vertical clearance—such as on the rear entrance AEC Bridgemaster—is comparatively simple, for they would often replace coil springs. The normal preference of passengers in stage-carriage services to sit on near-side seats is also counteracted by self-levelling air suspensions, and one would expect vehicle handling to be made easier and tyre wear to be reduced by fitting them.

Solid and Pneumatic for Japanese Railroads





Translation of an article by Haruhko Tohara of the Tetsudo Gijutsu Kenkyujo (Institute of Railway Technology) in Japan reveals that that country's railway authorities are becoming increasingly interested in use of rubber suspension systems for railway carriages. The author introduces the subject by quoting from an American SAE test in which an analysis of human "sensuous reaction" was made in terms of velocity, acceleration and jerk. More down to earth, he says that the noise level when travelling third class on a tramcar of the Shonan railroad is likely to reach 85 phons, which explains even better why they are trying pneumatic suspensions.

In Japan it was when rubber antivibration units were used for the bogie truck of a special second class train in 1951 that rubber was seriously considered for the first time as a means of improving comfort in a train. And in 1956, the first bogie truck adopting an air spring appeared on the Kyoto-Osaka Electric Train Company stock.

One bogie truck—of the DT20, which is used as a commuters' train by the National Railway electric train service—has a rubber cylindrical antivibration mounting installed as the axle spring in order to protect it from both high frequency vibration and inherent vibration of the coil-spring.

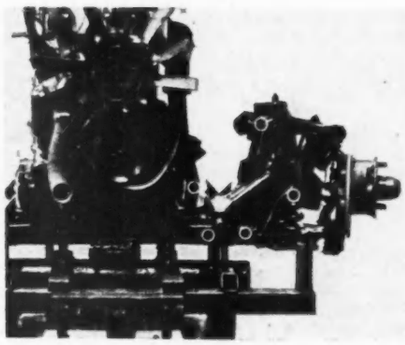
The illustration above shows the bogie truck of Kodama, Special Express, which uses an air spring of the bellows type as a pillow spring. Rubber vibration absorbers are used in connection with both the axle spring and the bolster anchor to control pitching.

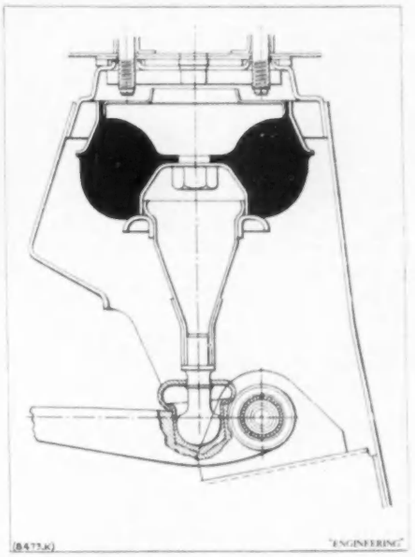
Mountings and Bushes for the Jaguar 2·4

The integral body frame construction used in the Jaguar 2·4 litre could have resulted in a noisy car, but careful choice and placing of rubber mountings and bushes has avoided this. Most of the components were made by Metalastik from natural rubber.

The front axle and steering, as a unit, are completely insulated from the main body and frame, the weight of the car being carried on the front axle in V rubber mountings. Fore and aft movement of the axle is controlled by forward locating torque arms through bonded rubber mountings.

The rear suspension features long cantilever springs with the centres carried in chassis box members, and the whole springs are encased in blocks of rubber specially designed to give calculated flexibility in a longitudinal plane.



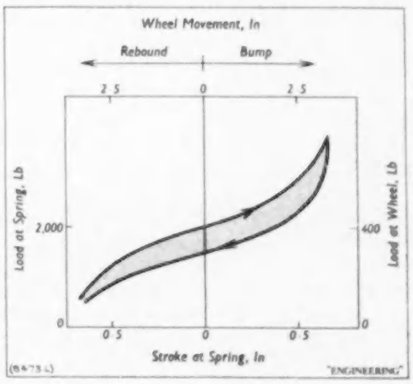


A BMC Baby with All-Rubber Suspension

Choice of rubber compound for the well-known rubber suspension units of the BMC babies was not difficult. Says Mr. Alex Moulton who developed the system: "We just used the purest natural rubber gum we could obtain with a carbon black filler." If there were any doubts about the suspension when it was introduced, they must certainly have been dispelled now that millions of miles have been clocked up by these vehicles.

One of these units is on view at the Natural Rubber Producers Research Association at Welwyn Garden City. This unit had a "quite exceptional test comprising 4·4 million cycles at 5 in wheel stroke. The normal life of a steel spring under similar conditions would be about ¼ million cycles." Rubber units with their progressive load characteristics are retained in the long-awaited 5 cwt versions of this car.

Several designs of rubber pad were tried before the present one was decided upon. This has a non-linear characteristic so that the suspension frequency is virtually constant under all forms of loading. The rubber to metal bonds by Dunlop seem adequate and there is no trouble from oil or water.



Plain Words

By Capricorn

Is the human dynamo on the way out? The gossip columns writers say that tycoons today are no longer like tycoons. The man who controls a vast industrial empire, known to the public by the little half-column photographs that are always appearing in the City columns, is known to his friends as a quiet type with a dry sense of humour—more like a university don with a dilettante's flair for business.

The trend originated, I think, with American television stars, though the influence can probably be traced back to the cinema. Anyway, wherever it started, we have today a school of television personalities who cultivate the relaxed manner. They exude a sense of perfect, unruffled control. Every movement, every note, every word, is effortless. Father's gloom and mother's irritableness at the end of the day are dispelled by the disarming simplicity of these chocolate box philosophers.

This same sense of perfect personal control is noticeably spreading to business men, executives, managers and all who make the industrial world tick. Though you have a fearfully heavy programme in front of you, you present a serene front to your visitors. Careful stage management by your secretary —or perhaps your P.A.—ensures that things happen according to plan. Your deputy appears miraculously at the precise moment when the discussion reaches the point where his specialist advice is needed. The discreet documents on your desk are shrewdly tailored to the needs of the discussion. The transport arrangements, the luncheon, the brief meeting with the chairman, the follow-up letters—all these things are laid on with such unobtrusive perfection that your visitor feels like a Home Guard lieutenant in the presence of an adjutant of a Guards battalion.

There is only one flaw in the technique developed by the American television stars: they have obviously been groomed for the job by others. Their relaxed manner is a facade which has been applied by cunning little back-room publicists. For that reason they can never attain the patrician bearing of the Guards adjutant, though they can give innocent pleasure to millions of viewers and calm the nerves of harassed managers from charge hands to Cabinet Ministers.

It's very ulcer-soothing to have a few people in business who go in for this relaxed-manner illusion, but I hope we retain some of the bouncing, bubbling personalities who raise dust wherever they poke their noses. They may be like steam locomotives that waste more fuel than they use, but you have to admire their energy. The Colonel Blimps of the 1920's and 1930's were ridiculed and caricatured, but they preserved a valuable tradition of discipline which was polished up and adapted when a great emergency arose.

Perhaps you are a human dynamo yourself? All power to you, Sir. Don't, I implore you, let Perry Como indoctrinate you.

Letters to the Editor

Grand Contour Canal

Sir, At the end of his extremely interesting article on "Contour Canal for National Water Grid?" (Engng., 15 July '60, p. 82) Mr. J. F. Pownall refers to a meeting of Members of Parliament which he addressed at the House of Commons last month. As I had sponsored that meeting I have, in the eyes of my colleagues, become identified with this project and I have received a number of comments from them.

Certain facts are clear. For example, there is more and more appreciation of the drain on our water supply due to increasing irrigation, especially in eastern England. There is more and more understanding that water is far too precious merely to be regarded as something to be hastened on its way to the sea.

All this will help to ensure support for parliamentary discussion of this project in the autumn. And in that discussion I hope that we shall hear more of the views of the farmers, the anglers and the pleasure boat enthusiasts. The Government is more likely to set going a thorough study of this scheme if it finds that it also interests people outside the worlds of water and transport.

Yours faithfully,
Geoffrey de Freitas.

House of Commons,
London, SW1.
4 August, 1960.

Cheaper and Quicker by Water

Sir, Your admirably judicious and well-informed article on the prospect before the waterways "Transport Cheaper and Quicker by Water" (Engng., 8 July '60, p. 56), none the less omits to mention one very important element in the present situation.

An ever-increasing number of disinterested observers are coming to believe, with this Association, that a prosperous future can be secured only by vesting the waterways system in a new and independent authority, a National Waterways Conservancy. The nationalised navigations (about two-thirds of the whole) constitute less than one per cent of the British Transport Commission's total undertaking; and many potential functions of the waterways, some of them revenue producing, cannot be the proper business of a transport organisation.

An outline of the case for a Conservancy, with suggested details of how it would work, will be gladly supplied by us at a cost of one shilling per copy, post free.

Yours very truly,
Robert Aickman,
Founder and Vice-President.

The Inland Waterways Association,
11 Gower Street,
London, WC1.
2 August, 1960.

Attracting Capital to Engineering

Sir, I have read with much interest the article "What Attracts Capital to Engineering?" (Engng., 22 July '60, p. 118).

There is one point in connection with the provision of finance by a finance house which I feel often presents difficulty to the company seeking financial assistance. This is the question of loss of sovereignty which to some degree must take place when a financial partner is taken in.

We at Charterhouse believe that this fear is largely dissipated by providing for and recognising that there is a community of purpose, not a conflict of interests.

Our philosophy is based upon going into partnership with the owner-managers of progressive companies which have a proven profit record over a number of years to demonstrate the soundness of the business and the ability of its management. The key to the partnership is that whereas we are in a position to provide the money we are *not* in a position to provide management; this must come from our partners.

We frequently put up substantial sums in the form of preference shares alongside a minority holding of ordinary shares. We thus commonly find ourselves with the major stake in a company in terms of actual money, but without the control that a majority ordinary shareholding would give and without a direct participation in the management of the company. In short, we put our fortunes very much in the hands of carefully chosen partners.

While our experience has been that this works well, we think it necessary to agree with our partners certain arrangements for our own protection. These are in the nature of "longstops" and, in normal circumstances, should not be a cause of friction—for the common aim is to make the business itself a success. We have no other axe to grind.

Yours faithfully,
P. R. M. Holborn,
Director.

Charterhouse Industrial Development
Company Limited,
30 St. Swithin's Lane,
London, EC4.
3 August, 1960.

Jarrah and Karri

Sir, I have read with interest the article by Mr. D. J. W. Dalby on "Jarrah and Karria: Two Heavy Duty Timbers" in Engng., 10 June '60, p. 784, which we have just received.

Unfortunately, there are two printing errors in this report:

The increase ratio for combined dead and live load is

$$\frac{L + D}{0{\cdot}8\,L + D}.$$

The deflection is proportional to $L + 3D$.

Yours faithfully,
E. W. Shilbury,
Head, Department of Engineering.

Perth Technical College,
St. George's Terrace,
Perth, Western Australia.
27 July, 1960.

Events in Advance

Birmingham to Sound 20 Railway Engine Whistles

As a result of numerous requests from persons residing in the Birmingham area, the City Museum and Art Gallery there have arranged to put a variety of engines on steam during the evening of Thursday, 29 September next.

The engines selected for this demonstration will include a compound beam engine by Easton, Amos and Sons, 1864; a steam hammer by Massey, 1873; an Aveling-Porter steam roller (stationary), 1892; a Ruston-Proctor portable engine, 1894; an organ engine by Savage, 1898; a Tangye colonial engine, 1902; and a uniflow engine by Galloway, 1924.

Arrangements are also being made to sound more than twenty whistles taken from various railway engines. The museum will remain open until 9 p.m. on this occasion and it is hoped that the concession will enable many people to enjoy the demonstration who are unable to attend the museum's normal "steam weekends."

Further details may be obtained from Mr. N. W. Bertenshaw, B.Sc.Tech., Keeper, City Museum and Art Gallery, Department of Science and Industry, Newhall Street, Birmingham 3, or by telephoning Birmingham Central 1022.

Heating and Ventilating to Have Own Exhibition

Heating, ventilating and air-conditioning techniques are becoming of increasing importance, not only in regulating conditions in living and working space—which, of course, includes factories and industrial plants as well as residential and office buildings—but also in connection with modern industrial processes themselves.

Industrial applications embrace air-treatment and handling equipment for such processes as filtration; dust, grit and fume collection; mechanical draught, which is receiving fresh importance with the passing of the Clean Air Act; and process heat exchange.

Early this year, a meeting attended by some 40 manufacturers in the heating, ventilating and associated industries decided that the enhanced importance of these industries was now such as to justify the holding of a specialised national or international exhibition to cater for their particular needs. They felt also that no existing exhibition covered sufficiently the wide range of equipment which was in use in their industries. An advisory committee was accordingly set up to organise an exhibition suited to the requirements of the heating and ventilating industries.

The event is to be known as the Heating, Ventilating and Air Conditioning Exhibition (short title HEVAC) and will be held at Olympia, London, W14, from 26 September to 6 October, 1961. The organisers for the exhibition are Industrial Exhibitors Limited, 9 Argyll Street, London, W1 (telephone GERrard 1622) and further particulars may be obtained from them.

Germany Displays Her Foundry Machinery and Techniques

Düsseldorf has again been selected as the venue for the coming German International Foundry Trades Exhibition, which will be held from 1 to 9 September, 1962, and will be the second event of the series.

The fair is of a specialised nature, organised for the benefit of foundrymen and the makers and users of castings. The range of exhibitions will, in the main, be comprised of foundry machines and equipment, basic raw materials, auxiliary materials and other requirements of that industry. As in 1956, when the first International Foundry Trades Fair took place, the Verein Deutscher Giessereifachleute (German Foundrymen's Association) will hold their annual meeting during the course of the fair.

Nordwestdeutsche Ausstellungs-Gesellschaft (NOWEA), 4 Ehrenhof, Düsseldorf, Germany, are the organisers of this exhibition and additional information, application forms, and so on are obtainable from them.

Exhibitions and Conferences

Men's Fashion Congress and International Men's Fashion Fair.—Sat., 27 Aug., to Mon., 29 Aug., in Cologne. Including textile machinery and manufacturing techniques. In the United Kingdom, applications should be made to Mr. Neven du Mont, 123 Pall Mall, London, SW1. Tel. WHItehall 8211.

Leather Goods Trade Fair, International.—Sat., 27 Aug., to Thurs., 1 Sept., at Offenbach. Including leather goods machinery. Apply to the Offenbacher Messe-Gesellschaft m.b.H., 110 Kaiserstrasse, Offenbach-on-Main, Germany.

Horological Exhibition, Eleventh International.—Thurs., 1 Sept., to Sun., 11 Sept., in Besancon. Organised by the Chamber of Commerce, 54 Grande Rue, Besancon.

Household Goods, International Exhibition.—Sat., 3 Sept., to Sun., 11 Sept., in Gothenburg. Organised by the Utstallningen Dagens Hushall, Kopmannens Hus, 52 Vasagatan, Gothenburg, Sweden.

Toys: Ratt Leksak ("The Right Toys") International Exhibition.—Sat., 3 Sept., to Sun., 11 Sept., in Gothenburg. Apply to Utstallningen Dagens Hushall, Kopmannens Hus, 52 Vasagatan, Gothenburg, Sweden.

Shop of Today ("Dagens Butik"), International Exhibition.—Sat., 3 Sept., to Sun., 11 Sept., in Gothenburg. Including shop fittings and accessories. Apply to Utstallningen Dagens Hushall, Kopmannens Hus, 52 Vasagaten, Gothenburg, Sweden.

Bicycle and Motor-Cycle Exhibition (IFMA).—Wed., 7 Sept., to Sun., 11 Sept., in Frankfurt. Apply to the Exhibition Management, 57 Friedrich-Ebert-Anlage, Frankfurt-on-Main, Germany.

Leather Week, International.—Thurs., 8 Sept., to Tues., 13 Sept., in Paris. Including leather goods machinery. Apply to the Semaine Internationale du Cuir, 2 Rue Edouard VII, Paris 9e.

Household Goods and Hardware Fair.—Fri., 9 Sept., to Sun., 11 Sept., in Cologne. In the United Kingdom, applications should be made to Mr. Neven du Mont, 123 Pall Mall, London, SW1. Tel. WHItehall 8211.

Instruments and Measurements, Fifth International Exhibitions and Conference.—*Commercial exhibition:* Sat., 10 Sept., to Sat., 17 Sept., in the Osterman Marble Halls, Stockholm. *Scientific exhibition:* Mon., 12 Sept., to Fri., 16 Sept., in the Royal Institute of Technology, Stockholm. *Conference:* Tues., 13 Sept., to Fri., 16 Sept., in the Royal Institute of Technology, Stockholm. Conference is being organised by the Royal Swedish Academy of Engineering Sciences and the Swedish Association of Technical Physicists. British participation is being organised by the United Kingdom Atomic Energy Authority, 11 Charles II Street, London, SW1 (Tel. WHItehall 6262), and the Nuclear Energy Trades Association.

Artistic Workshops, Autumn Exhibition.—Sat., 10 Sept., to Mon., 19 Sept., in Paris. Apply to the Salon Commercial et Professionnel des Atelieurs d'Arts, 13 Rue des Petites-Ecuries, Paris.

German Industries Exhibition, 11th.—Sat., 10 Sept., to Sun., 25 Sept., in Berlin. In the United Kingdom, applications should be made to Mr. Neven du Mont, 123 Pall Mall, London, SW1. Tel. WHItehall 8211.

Ghent International Fair, 15th.—Sat., 10 Sept., to Sun., 25 Sept., in Ghent. Agent in the United Kingdom: Mr. Neven du Mont, 123 Pall Mall, London, SW1. Tel. WHItehall 8211.

"Comptoir Suisse" National Fair, 41st.—Sat., 10 Sept., to Sun., 25 Sept., in Lausanne. Apply to the Swiss Embassy, 18 Montagu Plac, Beryanston Square, London, W1. Tel. PADdington 0701.

German Machine Tool Fair.—Sun., 11 Sept., to Tues., 20 Sept., in Hanover. Organised by the Verein Deutscher Werkzeugmaschinenfabriken (VDW), 6 Am Hauptbahnhof, Frankfurt-on-Main.

Staff Grading, Conference on.—Mon., 12 Sept., at the North British Hotel, Edinburgh. Organised by the British Institute of Management, 80 Fetter Lane, London, EC4. Tel. HOLborn 3456.

Utrecht International Autumn Trade Fair, 75th.—Mon., 12 Sept., to Sat., 17 Sept., in Utrecht. In the United Kingdom, applications should be made to Mr. W. Friedhoff, 10 Gloucester Place, London, W1. Tel. WELbeck 9971.

Electronic Trades Exposition, Upper Midwest.—Thurs., 15 Sept., to Sat., 17 Sept., at the Auditorium, Minneapolis. Organisers: Twin City Electronic Wholesalers' Association, 1915 Hiawatha Avenue, Minneapolis, Minnesota, USA.

Radio, Television and Electronics Exhibition, 22nd.—Thurs., 15 Sept., to Mon., 26 Sept., in Paris. Organised by the Syndicat des Constructeurs d'Appareils Radio Recepteurs et Televiseurs, 23 Rue de Lubeck, Paris 16.

Bolzano International Samples Fair.—Fri., 16 Sept., to Mon., 26 Sept., at Bolzano. Apply to the Fiera Compionaria Internazionale di Bolanzo, C.P. 297, Bolzano.

Finnish Industries Fair.—Fri., 16 Sept., to Sun., 2 Oct., in Helsinki. Apply to the Osuuskunta Suomen Messut, Messuhallit, Helsinki, Finland.

Textiles: International Cotton, Artificial Fibres, Chemical Products and Textile Machinery Fair.—Sat., 17 Sept., to Mon., 26 Sept., in Busto Arsizio. Offices of the fair: 1 Via Mameli, Busto Arsizio, Italy.

Plovdiv International Fair.—Sun., 18 Sept., to Sun., 2 Oct., in Plovdiv, Bulgaria. In the United Kingdom, apply to the Bulgarian Trade Department, 1 Hall Road, London, NW8. Tel. LORds 1011.

Data Transmission, International Symposium.—Mon., 19 Sept., to Wed., 21 Sept., at the Technische Hogeschool, The Hague. Sponsored by the Benelux Section of the Institute of Radio Engineers in cooperation with Het Nederlands Radiogenootschap. Apply to Mr. B. B. Barrow, secretary of the Benelux Section, Institute of Radio Engineers, P.O. Box 174, The Hague, Holland.

Business Aircraft Association Convention and Forum, 13th Annual National.—Tues., 20 Sept., to Thurs., 22 Sept., at the Ambassador Hotel, Los Angeles. Organised by the National Business Aircraft Association Inc., 344 Pennsylvania Building, Washington 4, DC, USA.

Polymers: Symposium on High Temperature Resistance and Thermal Degradations of Polymers.—Wed., 21 Sept., to Fri., 23 Sept., in the William Beveridge Hall, Senate House, University of London, London, WC1. Organised by the Plastics and Polymer Group, Society of Chemical Industry, 14 Belgrave Square, London, SW1. Tel. BELgravia 3681.

Book Fair.—Wed., 21 Sept., to Mon., 26 Sept., at Frankfurt-on-Main. Including printing and office machinery. In the United Kingdom, apply to Lep Transport Ltd., Sunlight Wharf, Upper Thames Street, London, EC4. Tel. CENtral 5050.

Catalysts, Symposium.—Thurs. and Fri., 22 and 23 Sept., at Liverpool. Organised by the Chemical Engineering Group of the Society of Chemical Industry, 14 Belgrave Square, London, SW1. Tel. BELgravia 3681.

Marseilles International Fair, 36th.—Thurs., 22 Sept., to Mon., 3 Oct., in Marseilles. Agents in the United Kingdom: Butlers Advertising Service, 22 St. Giles High Street, London, WC2. Tel. TEMple Bar 5905.

Innsbruck Export and Samples Fair, 28th.—Sat., 24 Sept., to Sun., 2 Oct., at Innsbruck. Apply, in the United Kingdom, to the Office of the Austrian Foreign Trade Representative, 1 Hyde Park Gate, London, SW7. Tel. KNIghtsbridge 6938.

Photo and Ciné Exhibition, International (PHOTOKINA).—Sat., 24 Sept., to Sun., 2 Oct., in Cologne. In the United Kingdom, applications should be made to Mr. Neven du Mont, 123 Pall Mall, London, SW1. Tel. WHItehall 8211.

Medical and Hospital Equipment, First International Exhibition.—Sat., 24 Sept., to Sun., 2 Oct., in Brussels. Apply to the Salon International de l'Equipement Medical et Hospitalier, 171 Avenue du Domaine, Brussels 19, Belgium.

Technical Exhibition, Tenth International.—Sat., 24 Sept., to Tues., 4 Oct., in Turin. Apply to the Salone Internazionale della Tecnica, 60 Corso Galileo Ferraris, Turin, Italy.

Boating Trade Show, Fourth Annual National.—Sun., 25 Sept., to Wed., 28 Sept., in Chicago. Organised by American Shows Inc., 30 North La Salle Street, Chicago 2, Ill., USA.

Instrument-Automation Conference and Exhibition (ISA).—Mon., 26 Sept., to Fri., 30 Sept., at the Coliseum, New York. Organised by the Instrument Society of America, 313 Sixth Avenue, Pittsburgh 22, Pa., U.A.S.

Communications, Conference on.—Tues., and Wed. 27 and 28 Sept., at Pembroke College, Oxford. Organised jointly by the British Institute of Management and the Ministry of Labour. Apply to the Conference Office, British Institute of Management, 80 Fetter Lane, London, EC4. Tel.: HOLborn 3456.

Austenite: Vacation Course on Transformation of Austenite.—Tues., 27 Sept., to Fri., 30 Sept., at the Battersea College of Technology. Apply to the secretary (metallurgy courses), Battersea College of Technology, London, SW11. Tel. MACaulay 1031.

Nautical Exhibition, 26th International.—Fri., 30 Sept., to Sun., 16 Oct., in Paris. Apply to Chambre Syndicale des Industries Nautiques, Bateau du Salon Nautique, Port Debilly, Paris 16.

Optical Instruments and Techniques, Conference.—Mon., 10 July, to Fri., 14 July, 1961, in London. Arranged under the auspices of the International Commission for Optics, by the British National Committee for Physics. Inquiries should be sent to Mr. K. J. Habell, National Physical Laboratory, Teddington, Middlesex.

Inorganic Polymers, International Symposium on.—Tues., 18 July, to Fri., 21 July, 1961, at Nottingham University. Sponsored by the Chemical Society, Burlington House, Piccadilly, London, W1. Tel. REGent 0675.

Pipes, Pipelines, Pumps and Valves, Second International Exhibition and Convention.—Mon., 9 April, to Fri., 13 April, 1962, at Earl's Court, London, SW5. Organised by the Exhibition Division, Scientific Surveys Ltd., 97 Old Brompton Road, South Kensington, London, SW7. Tel. KNIghtsbridge 9360.

World Power Conference, Sixth Plenary Meeting.—Sat., 20 Oct., to Fri., 26 Oct., 1962, in Melbourne. Organised by the Australian National Committee, 45 Little Lonsdale Street, Melbourne C1, Victoria, Australia. Theme: "The Changing Pattern of Power." In Britain, application may be made to the secretary, British National Committee, World Power Conference, 201-202 Grand Buildings, Trafalgar Square, London, WC2. Tel. WHItehall 3966. *Note:* There will be a Sectional Meeting in Switzerland in 1964.

PIPE BENDER

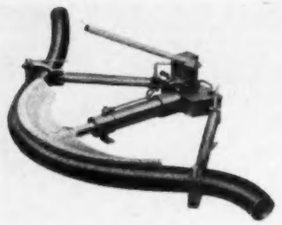
Portable for Site Use

A NEW pipe bender is a lightweight unit designed for use on site.

Two sizes are made, one with a range from 2 in to 4 in and the other for pipes from 4 in to 8 in bore. Formers are available for bending pipes of 2 in, 2½ in, 3 in and 4 in bore through 90° in one operation, without heating or filling. Above these pipe sizes radii are produced by successive bends.

The machine consists of a Staffa heavy duty hydraulic ram, to the base of which is attached the oil reservoir and arm trunnion brackets. The arms that carry the pipe clamps are telescopic and are simply positioned by means of a pin. The use of hinged arms that fold into a compact unit makes the machine suitable for easy transportation.

A weatherproof pump unit is mounted on top of the tank. The body of this unit is made of high grade light alloy and is guaranteed against accidental breakage. The pump has two pistons to give fast approach and rapid bending of light tubes. For bending to maximum



capacity the physical effort is reduced by means of by-passing one of the cylinders. A four way valve permits powered automatic withdrawal of the ram to free the former from the workpiece after bending.

The pump is protected against overload by a built-in pressure relief valve, and the inlet is fitted with a fine mesh strainer. The pump body is internally drained back to the tank to eliminate external leaks. If required, these machines can be fitted with air-hydraulic pumps or electric drive to convert them to power operation. *Chamberlain Industries Limited, Staffa Works, Leyton, London, E10.*

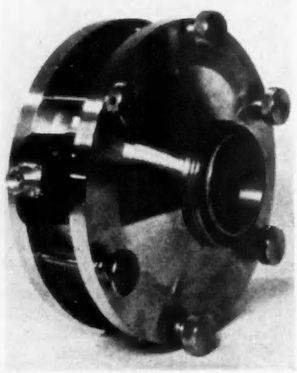
LIQUID METER

Electromagnetic System

THE Unipulse is a meter for liquids of different viscosity, acidity, alkalinity, and temperature.

This meter uses an electromagnetic system to transmit liquid flow data to remotely positioned indicators and control devices. The operation is on the rotary piston principle, the piston rotations being counted electromagnetically so that all seals are eliminated. The pick-up is such that signal amplitude remains constant regardless of flow rate.

The piston size is chosen to displace an exact volume for each cycle, allowing transmission to be in decimal notation without gearing. Four models are being made with minimum and maximum flow rates ranging from 5 to 300 and from 100 to 12,500 gallons per hour. The meters are made in gunmetal or stainless steel with bodies of aluminium. Pvc mouldings are at present being tested. With a constant head or constant pump output the Unipulse can be calibrated to an accuracy of within 0·25 per cent. It can be fitted direct



in the pipeline and applications include indicating total amount of liquid passed, rate of flow and batch control. It is claimed particularly that due to their low friction characteristics the meters are suitable for very low flow rates. *Measurement Limited, Lower Belgrave Street, London, SW1.*

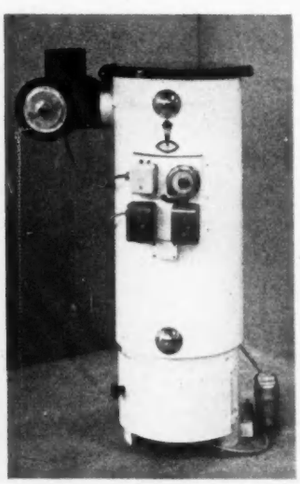
INDUCED DRAUGHT BOILER

Silent Running

A NEW oil-fired induced draught boiler is claimed to be almost silent in operation and requires a very short flue.

The boiler uses a vapourising burner and oil of about 28 sec. viscosity. There are four sizes in the PID range, with outputs of 35,000, 45,000, 50,000, 60,000, and 70,000 Btu per hour. The smallest is fitted for 1½ in flow and return pipes and the others for 2 in pipes. All models are 17 in in diameter and have a 6 in flue, but vary in height from 36 in to 60½ in.

Above the burners there is a series of water tubes crossing from side to side in a spiral formation, so that the best heat transfer may be obtained. A pilot burner consuming about one-fortieth pint per hour supplies the ignition. It also keeps the combustion chamber and flue warm, giving good combustion directly the main fuel is switched on. Fully automatic controls are fitted. The induced draught fan assembly can be mounted in three positions to suit any particular application and the flue can pass out



horizontally or vertically as required. There is an adjustable draught regulator. *Perkins Boilers Limited, Mansfield Road, Derby.*

PIPE SCREWING MACHINE

Transportable

A NEW transportable pipe screwing machine now on the market can be supplied for standing on a bench or on a trolley as illustrated.

The machine is designed for pipe, bolt or bar work in the workshop or on site. The capacity is from ⅛ in to 2 in in BSP; API; conduit; Briggs; and ANF threads, and from $\frac{7}{16}$ in to 1½ in in Whitworth, BSF, and UNF threads. Special chasers can be provided.

In addition to the standard range the machine can be adapted to take up to 8 in diameter BSP by the fitting of a universal tail shaft and a receding head.

A particular claim for the machine is the speed; the cutting time for a 2 in BSP taper is less than one minute; die changing takes only two minutes and changing from taper to parallel or vice versa only three minutes. Available for use with the machine are cutting-off and de-burring attachments: one deburring cutter covers all sizes from ¼ in to 2 in.

The work is driven by a positive grip-

ping spin chuck and there is also a centralising spin chuck fitted at the rear of the machine. Also at the rear is incorporated an integral grinding fixture. The tangential chasers are capable of many regrinds. *Smart and Brown (Machine Tools) Limited, 25 Manchester Square, London, W1.*

SUCTION CLEANER

Air Operated

COMPRESSED air is used to operate the Air-O-Flow suction cleaner which can be used for most industrial work.

Compressed air from a standard mains supply passes through a jet in the head of the machine and is dispersed in the container. In passing, it creates a vacuum in the suction pipe sufficient to draw up dirt and dust, nuts and bolts and any items lying around. Liquids can also be sucked up and one of the standard uses is to empty swarf tanks.

The action is controlled by a trigger grip on the head and the air consumption is approximately 9 cu. ft per minute. The steel container is stove enamelled and measures 16 in high by 11 in diameter; the unit stands 23½ in high overall with a total weight of 14½ lb. Three nozzles are supplied as standard.

When the unit is working with an air line pressure of 80 lb per sq in, the suction obtainable is 45 in water gauge, enough to hold a weight of 1½ lb at the nozzle. There are no moving parts to wear out and the whole is intrinsically

safe for use with inflammable gases. A removable debris bag can be used or the discharge can be direct into the container. Alternatively the head can be removed from the tank and the discharge made into a separate vessel. *Exhall Grinding and Engineering Company Limited, Bayton Road, Exhall, Coventry.*

BAND FILE

Throat Depth 19⅝ in

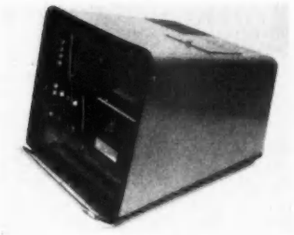
NOW available in this country is a new Thiel bandsawing and filing machine, model 117.

Three saw guide wheels are used running on shielded ball bearings, giving a throat depth of 19⅝ in. The front upper wheel is adjustable to take up tension. Power is supplied by a 1½ h.p. motor mounted in the base and controlled by a foot switch. Drive is by a variable speed unit with an infinitely variable range from 50 to 3,000 ft per minute.

The 24 in square table is mounted on a trunnion bracket allowing tilting up to 30° right or left and up to 15° front and back. The upper and lower saw guides are adjustable allowing a maximum thickness of work of 9¾ in. A magnifying glass and low voltage work light are included as standard equipment as is an air pump for swarf disposal. A butt welding and annealing unit is fitted, and a grinding wheel and guillotine. *Rockwell Machine Tool Company Limited, Welsh Harp, Edgware Road, London, NW2.*

RECORDER

Very High Writing Speeds



A NEW direct writing oscillograph recorder will give a well defined trace at writing speeds in excess of 12,000 in per second.

The instrument is designed as a 12 channel unit and is available with matched amplifiers and power supply units if required. It uses paper 6 in wide sensitive to ultra-violet light, and pencil type galvanometers which focus light from the source on to the paper. Three additional galvanometers are fitted for use as time and event markers but can also be used as recorders if needed. Two of them can be fed internally with a timing mark at the mains frequency. The paper does not need to be handled in a dark room.

A 200 ft roll of paper can be used, loaded through the front panel. There are eight speeds from the gearbox covering paper speeds from 5 in per minute to 150 in per second. All gears are permanently meshed and the speeds are selected by push buttons on the front panel which operate solenoids and clutches. Stopping and starting of the paper is also under push button control, either local or remote. A footage selector is fitted that stops the paper after a chosen length has been exposed.

The optical system is prefocused, except that the arc in the lamp can be moved laterally to obtain maximum intensity on the galvanometers. The writing speed of 12,000 ft per second corresponds to a 1,000 c/s sine wave with a 4 in peak to peak amplitude. A trace interrupter operating sequentially is used to identify each trace. The maximum voltage between any two galvanometers is 500 V. *Savage and Parsons Limited, Watford, Hertfordshire.*

CO_2 WELDER

Deposits 12 lb of Metal per Hour

A CLAIM for the Philips manual CO_2 welding equipment is that it is possible to deposit up to 12 lb of metal per hour.

The equipment consists of a three wheeled unit carrying wire reel, wire feed mechanism, two gas cylinders and all electrical and gas controls. The hand gun will operate with currents up to 320 A and is claimed to have been designed to eliminate operator fatigue. Control is by trigger. The weight in the hand is 3½ lb, with the feed cable attached; a heat barrier is incorporated in the body of the gun and a heat proof hand shield is fitted.

The feed cable is composite and includes the tube carrying the welding wire and gas, and the switch and current leads. Its length is 12 ft and the machine head rotates through 180° on a turntable to give a wide coverage. Wire of 0·9, 1·2 and 1·6 mm diameter can be used and it is only necessary to change the gun contact tip when changing wire size. The holder takes 44 or 56 lb coils and wire speed is continuously variable from 6 to 54 ft per minute by a graduated control on the gearbox. Feed is by a solenoid operated pressure roll; straighteners are fitted and a friction brake. There are full safety interlocks. *Research and Control Instruments Limited, 207 King's Cross Road, London, WC1.*

SLOTTER

Double Wheel Head

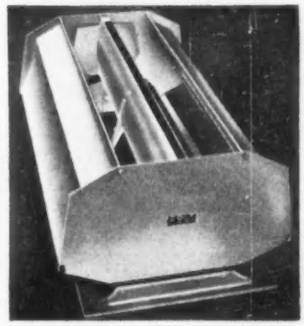
NOW being made in this country is a slotting head for attaching to a Lesto angle grinder for cutting channels in brickwork.

The head incorporates two 9 in diameter nylon bonded abrasive wheels which can be spaced to suit the width of the slot required. The depth of the channel can also be set by the adjustable guard fitted to the head bracket. The illustration shows the unit in action with the protective guard removed to show the cutting discs. The speed of cutting in Fletton brick is up to 12 ft per minute. The motor has a nylon air filter.

Chief claims for the machine are: the speed of cutting which is said to be two or three times that when using tungsten carbide; the low cost of the cutting disc; the long disc life (dependant on the material they will cut between 50 and 100 ft of slot); and the alternative use of the machine with other types of wheel for surfacing concrete, cutting steel reinforcing rod and angle, and general surface preparation. Maximum depth of cut is 1½ in and width 1$\frac{5}{16}$ in approximately. *Trend Industrial Equipment Limited, 77 and 95, Dudden Hill Lane, London, NW10.*

VENTILATOR

Adjustable Flaps



A NEW roof-mounted ventilator is fitted with hinged flaps which can be adjusted to suit weather conditions.

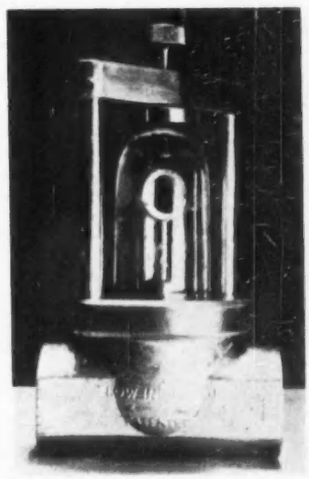
The type O/SR has two hinged flaps, shown fully open in the illustration, which under cord control can be swung down to a half way position or fully closed to seal the opening. It is claimed that fewer ventilators are needed as the system can be designed for average conditions and set to suit weather changes. Aerofoil curves are used so that the extraction is positive under all conditions of stack action and wind, since an area of low pressure is always present immediately above the ventilator.

In the normal (half-way) position the flaps afford complete weathering; opening them fully increases the extraction rate by about 50 per cent; it also increases the amount of natural lighting to the building and permits the release of radiant heat to the atmosphere.

The overall dimensions of one standard size are 6 ft long by 2 ft 4½ in wide at the greatest width. The opening to the interior is 1 ft 2 in wide. The ventilators project 1 ft 6¼ in above the roof level. A second standard size is 4 ft 6 in long but has the other dimensions the same. The fixing flanges of both models are 6 in long at the top, 4 in at the bottom and 5 in at the sides. The larger weighs 58 lb and the smaller 41 lb. There is also a wide range of inverted top ventilators with or without dampers for closing them. *Colt Ventilation Limited, Surbiton, Surrey.*

FLOW INDICATOR

For High Pressures



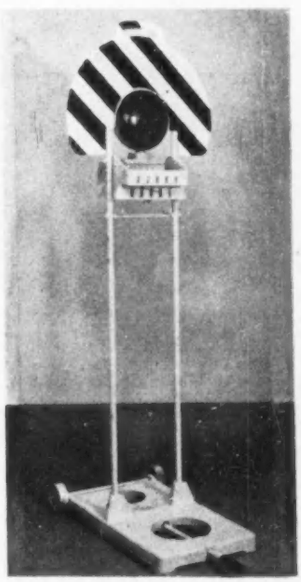
ARKON visual flow indicators are now available with caps that will stand pressures up to 200 lb per sq. in.

The principle of all Arkon flow indicators is that liquid passing through a pipe to which the indicator is fitted spins a chromium plated ring under a glass dome. If the flow stops for any reason, the ring stops and thus provides visual warning. It is claimed that the movement of the ring is clearly visible even from a distance in a bad light.

Indicators of this type are made in sizes from ½ in to 2 in and can be adjusted to suit high or low velocities of flow. The spindle impeller assembly is fitted into a cartridge housing which is easily removed and reset. Indicators are set for the flow rate as ordered, but the complete cartridge assembly can be exchanged at any time for another, set to a different flow rate. The assembly is also interchangeable between sizes of indicator. Changing from high to low flow rate consists of changing the guide plate to an alternative position. With this arrangement flows from 0·6 to 80 gallons per minute can be handled. *Walker, Crossweller and Company Limited, Cheltenham, Gloucestershire.*

BEACON

Flashing Lamp



DESIGNED for use as a warning beacon for road works, the Simplite has a flashing lamp and provision for sign boards.

The unit is portable and can be dismantled in a matter of seconds. The handle can be drawn out from the base enabling the beacon to be pulled along on the rear wheels. The lamp box is adjustable to take either a standard square road danger lamp or the new transistorised flashing unit which has a working life of 1,500 hours when supplied by two small dry batteries. The beam angle is adjustable.

The legs are ¾ in heavy gauge steel tubes with an adjustable sign hanger between them. The base plate and the halo around the lamp are made of aluminium alloy. Holes in the base reduce weight and also the suction effects of passing vehicles. With lamp and battery the beacon weighs 32 lb; it stands 5 ft 11½ in high overall and is 1 ft 7½ in wide. *William R. Selwood Limited, Chandlers Ford, Hampshire.*

LIFT TRUCK

Battery Operated

CLAIMS for the Big Joe battery-operated lift truck are its exact positioning and low cost.

There are two sizes, for lifting 1,000 or 1,500 lb respectively to a height of 4 ft 9 in. The turning radius is only 38 in so the trucks can be operated in narrow passages for intermediate handling jobs. The forks are 26 in long with a lowered height of 4½ in and separated by a gap of 15½ in. The distance across the forks is 26 in. A slip-on platform measures 26 in by 27 in. Overall dimensions of the trucks are 67 in high by 26 in wide, and the smaller is 42½ in long as against 43½ in for the larger.

Power is supplied by a standard 12 volt battery fitted in the case. A built-in selenium charger, operating on full wave, is standard equipment. The charging lead can be plugged in to any 220/240 V a.c. socket, a full charge being imparted during the night. Charging rate is automatically reduced as the battery nears full charge.

Lifting and lowering are under the control of a single hand lever which also controls speed. The maximum rate of lift is 40 ft per minute. Dual hand operated floor brakes are fitted on both models, with an easy adjustment to take up wear. On both models the maximum load is rated at a centre distance of 13 in; at 18 in the handling capacity is reduced to 650 lb for the smaller and 1,000 lb for the larger model. The weights of the trucks are 400 lb and 540 lb respectively. *ScotMec Works, Ayr, Scotland.*

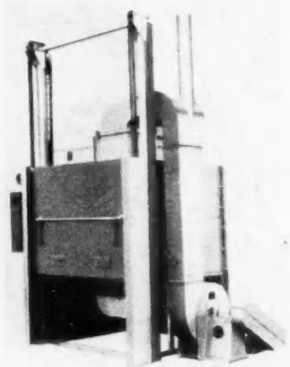
DRYING OVEN

For Glass Fibre Mouldings

A DRYING oven and a rotary preformer machine have been added to a 150 ton moulding press to make a complete range of machines for glass fibre mouldings.

The Preform drying oven has internal measurements of 3 ft 4 in square by 3 ft 6 in high in the model for the 36 in preformer, and 4 ft 4 in by 4 ft 6 in for the 48 in size. The internal base of the oven is perforated and forms the mouth of the discharge ducting. It is 3 ft above floor level. A fan, driven by a 10 h.p. motor, is positioned at floor level to supply the recirculating heating. Automatic by-pass damper control is fitted in the discharge ducting to reduce heat losses, connected to the 40 kW heater which is mounted in the top of the oven. There is a double lining of 16 gauge steel with rock wool insulation between the walls.

The fan is capable of handling 4,400 cu. ft of air per minute at 6 in water gauge when running at 1,460 r.p.m. Normal supply for the motor is 400/440V 50 cycles, three phase, but can be varied to suit requirements. Safety devices ensure that on opening the door the hot air is by-passed by means of a damper, obviating a rush of air. Removable panels are fitted to the ducting for cleaning purposes. *BIP Engineering Limited, Streetly Works, Sutton Coldfield.*



OILING PEN

With Extending Tube

A DISPENSER in the form of a pocket pen is now available for Electrolube oils.

The dispenser, which consists of a transparent plastic reservoir with plastic caps, measures approximately ½ in diameter and 5½ in long with the cap in place. Removing the cap sharply draws out the extending "snorkel" tube to a length of 3 in. The tube has an outside diameter of about $\frac{1}{16}$ in so it can be inserted in small openings. Pressure on the transparent reservoir forces oil along the tube at a rate controlled by the amount of pressure applied. The tube is returned to its original position by the replacement of the cap.

At the base of the tube is a plastic foam washer that can be used to oil bigger surfaces, being charged from the tube itself. The dispensers are made in two colours: green for use with the firm's grade of oil for non-arcing contacts, and red for electrical contacts. *Electrolube Limited, Slough Estates House, 16 Berkeley Street, London, W1.*

TIMER

Accurate Repetition

LOW costs and high repetition accuracy are the two main claims made for a new series of process timers and delay switches.

The timers, type TRU3, are single-stage units in which the time interval set by the control knob starts on completion of the initiation circuit; that is the relay is energised on initiation and is de-energised at the end of the time interval. The timer is automatically reset provided that the initiation circuit is opened before the next operation is to start.

The delay switches DRU3 differ from the timers in that the relay is energised from the moment of switching on power until the end of the set interval. The initiating switch must be kept closed until the end of the preset time; on being opened, resetting occurs. For both types the control knob is situated on the chassis and is accessible only on removing the cover as in the illustration. There are three timing ranges: from 1 to 15 seconds; from 5 to 100 seconds; and from 15 to 300 seconds. Repetition accuracy is to within 1 per cent with normal mains voltage fluctuations.

Power supplies are for 110 V 225 V and 400 V 50-60 cycles. The standard units have 1 normally open and 1 normally closed contact rated for 5 A at 250 V non-inductive, and a similar pair rated for 250 mA at 50 V, also non-inductive. The units are housed in dust and moisture proof steel cases. *Elcontrol Limited, Wilbury Way, Hitchin, Hertfordshire.*

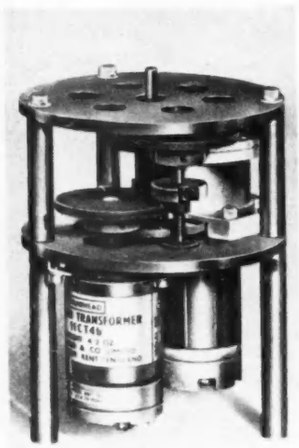
SERVO GEARBOX

Modular Construction

A WIDE range of servo gearboxes is now being made to high accuracy based on a modular system.

The illustration shows one example. Standard plates are used for mounting the components, the basic form being a box conforming to DEF 5000, wherein up to seven shafts are mounted in ball bearings. All components are made from corrosion resistant materials, and the ball bearings are friction tested to EL 1889 and are double shielded. The case is sealed against dust.

Gear ratios available range up to 43,000,000 to 1 using precision cut gears to Admiralty Class I. There is provision for up to six components, including servo motor, potentiometers and synchros. For "bread-board" and prototype work the components are interchangeable. The shafts at any step are extendable at both sides. All ratios are fitted with torque eliminating clutches, and eddy drag dampers are available. There is zero backlash in all ratios by using spring-loaded split gears; with solid gears backlash in a 1 to 1 ratio is less than 15 minutes of arc. *Reliance Gear Company Limited, Almondbury, Huddersfield, Yorkshire.*



DEHYDRATOR

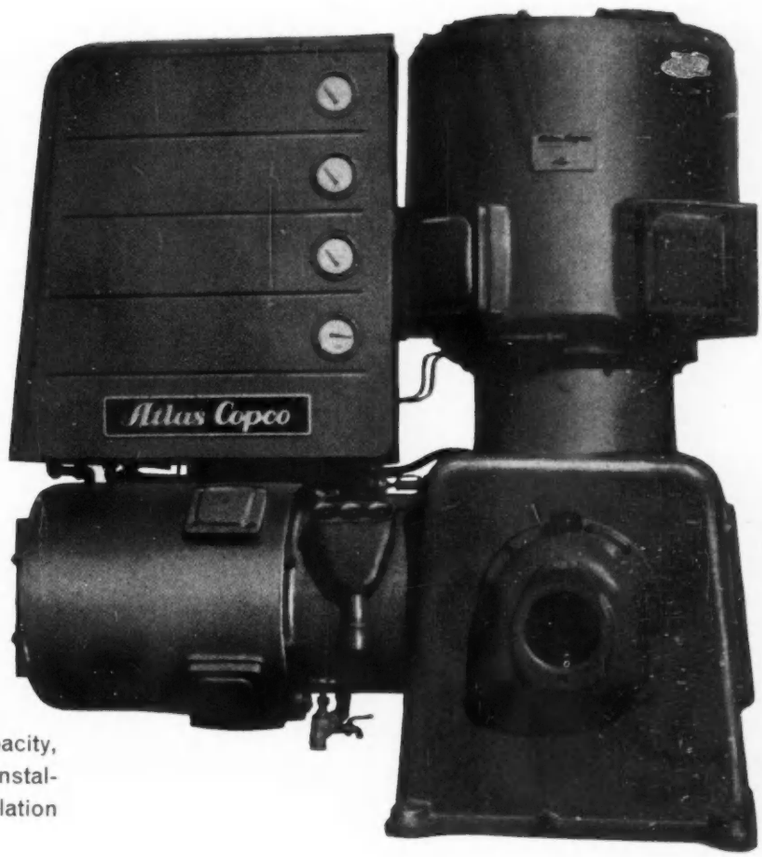
For Acetylene Gas

THE Autocet dehydrator illustrated has been introduced for insertion in welding plant to remove moisture from generated acetylene gas.

The unit is mounted in the gas line before the gas-fluxer that adds flux automatically to the flame in welding operations. It makes possible the use of generated gas with this device as the presence of moisture causes the flux to precipitate. The dehydrator is fitted after the hydraulic valve serving the welding point. It has an overall length of 30 in and a cylinder diameter of 3½ in. It is fitted with brackets for wall mounting.

The gas passes through an inlet to a tube where most of the moisture is deposited out under gravity. Leaving the tube, the gas passes through silica gel crystals to remove the remaining moisture. The crystals are visible through a window to display the colour change that occurs when they are saturated and ready for replacement. *Weldcraft Limited, Slough, Buckinghamshire.*

Here's Air Power at **ROCK BOTTOM** cost



ER6
HEAVY-DUTY Compressor for reliable 3-shift operation

Atlas Copco's ER6 compressor delivers air at the lowest possible cost. Designed to incorporate *every* economy factor, it combines the lowest possible running costs with low installation costs and a space saving design.

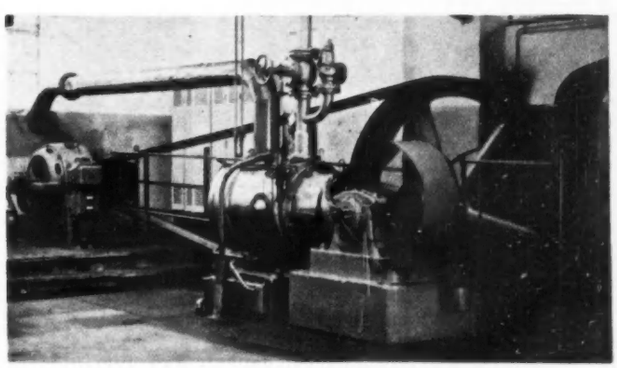
The ER6 delivers 1,075 cfm at 100 psi (30.4 m^3/min at 7 kg/cm^2) for a power consumption that is absolutely rock bottom. Thanks to a new type of intercooler, water consumption is only 440 imperial gallons (2,000 litres) per hour—a *quarter* the consumption of most similar machines. The ER6 is compact. Occupying only half the space usually required for machines of its capacity, it saves expensive factory space. In addition, installation costs are lower as new, cheaper installation methods are employed.

RANGE OF STATIONARIES

From 2.5 to 20,000 cfm, there is an Atlas Copco stationary compressor to suit every requirement. Whatever the design factor—compactness, low installation cost, low operating cost, or a combination of all three—Atlas Copco stationaries are high-performance machines you can rely on.

Sales and Service in Ninety Countries

With companies or agents in ninety countries, Atlas Copco is the world's largest organisation specialising solely in compressed air equipment. Products include stationary and portable compressors, rock drills, loaders, hoists, air tools and paint-spraying equipment. Wherever you are, the international Atlas Copco group offers expert advice and provides a complete after-sales service.



Built to last! This Atlas Copco compressor was installed at the Bofors engineering works (Sweden) in 1907. It is still in operation

WRITE FOR THE LEAFLET

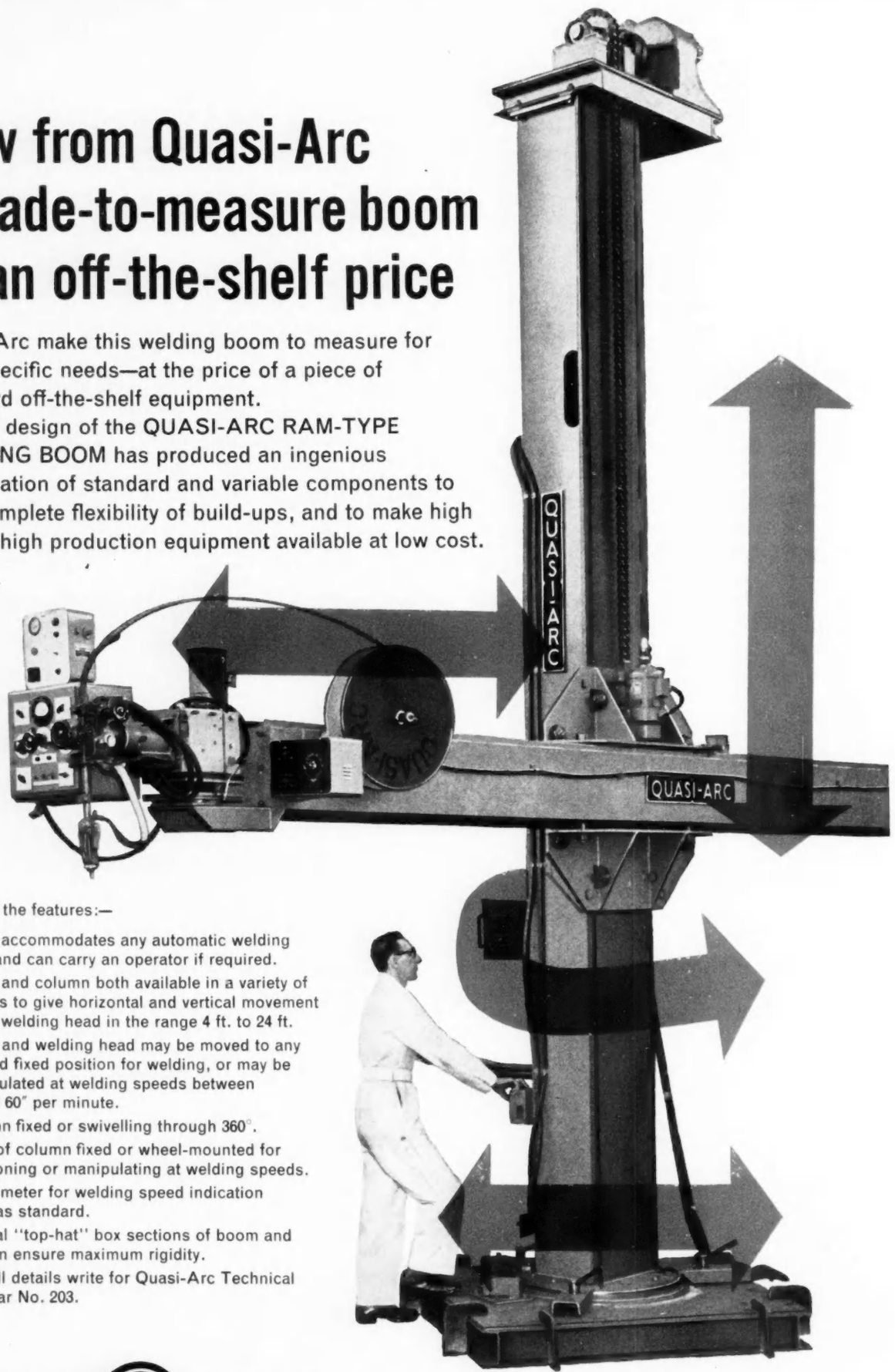
Leaflet E1127 gives full details of the ER6 compressor. Write for a copy to your local Atlas Copco company or agent or to the address below.

Atlas Copco puts compressed air to work for the world

Atlas Copco AB, Stockholm 1, Sweden. In the U.K. Atlas Copco (Great Britain) Ltd., Hemel Hempstead, Herts.

Now from Quasi-Arc a made-to-measure boom at an off-the-shelf price

Quasi-Arc make this welding boom to measure for your specific needs—at the price of a piece of standard off-the-shelf equipment.
Careful design of the QUASI-ARC RAM-TYPE WELDING BOOM has produced an ingenious combination of standard and variable components to give complete flexibility of build-ups, and to make high quality high production equipment available at low cost.



Check the features:—

- Boom accommodates any automatic welding head and can carry an operator if required.
- Boom and column both available in a variety of lengths to give horizontal and vertical movement of the welding head in the range 4 ft. to 24 ft.
- Boom and welding head may be moved to any desired fixed position for welding, or may be manipulated at welding speeds between 6″ and 60″ per minute.
- Column fixed or swivelling through 360°.
- Base of column fixed or wheel-mounted for positioning or manipulating at welding speeds.
- Tachometer for welding speed indication fitted as standard.
- Special "top-hat" box sections of boom and column ensure maximum rigidity.
- For full details write for Quasi-Arc Technical Circular No. 203.

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Human Element

The Benefits of Profit Sharing

IF AN employee receives a fair wage, giving him a share of the profits is dissipating profits that should properly be ploughed back into the company's further development.

If he is not receiving his due, then a profits-share hand-out is a method of gaining extra credit for paying the employee what he should be earning anyway. These are the arguments against profit sharing with employees.

On the contrary, profit sharing identifies an employee with the firm's fortunes, gives him an incentive to do better work and to acutally think on behalf of " his " company. The arguments in favour of relating part of the employee's reward to the success of the enterprise are self-evident.

Raising Status

Which way to turn?

The Conservative Party, the Opposition, and more enthusiastically the Liberal Party, are all in favour of suitable profit sharing schemes. The Liberal party, see such schemes increasing status and responsibility and spreading more widely the wealth of industry, the last point seems more the function of salaries but then thought in this field is not always limpid clear.

The current issue of *Occupational Psychology*, the journal of the National Institute of Industrial Psychology, carries a closely detailed and reasoned article on profit sharing which makes it plain that some of the compulsory profit sharing overseas is only another way of financing what in Britain are called Welfare State benefits.

It is not easy to know what is meant by the word profits in a Communist state but apparently in Yugoslavia every company is required to pay a proportion of net profits to the employees. The subject even affects international trade, in that Indonesia does not welcome foreign firms setting up there unless they look favourably upon co-partnership and profit sharing.

Need for Expansion

The author of *Occupational Psychology's* article contends that all profit sharing is at present at best an attempt at social justice which is misguided either in its principles or its arithmetic, while at worst it is a disguised " hand out."

Calling for clearer principles and more reasoning in profit sharing he goes on to look at certain types of profit. Justifiable profits, as opposed to fortuitous profits or unjustifiable profits, are the only type on which, if there is to be any profit sharing at all, a scheme could be based. And, as the author argues, the socially just profits which may be described as justifiable should be retained for expansion and improvement.

In addition to this sobering thought there is the contribution of the Chancellor of the Exchequer who has suggested that the benefits of higher productivity should not go entirely into greater profits and wages but should be shared with the consumer.

In other words into price cuts. This produces a highly interesting possibility. It is that the firm which finds itself at the end of the year in a position to share a substantial profit with its employees, could instead announce a cut in prices.

Not only would this spread what the Liberals call the wealth of industry more widely, it would increase the competitive position of the firm, to the advantage of its employees. Of course the staff might disagree. It is one thing to preach morality but much more difficult to give up sin.

French Students Prefer Private Industry

At this time of the year the circuses of talent spotters have been their ways round the universities picking up likely young men for managerial and technical posts. The number of graduates preferring a career in industry to one in the professions, especially teaching, is increasing. There is also a marked preference for private industry over the nationalised sector.

Is this also true abroad? The answer, so far as France is concerned, is given in a report on a series of interviews carried out by a French business weekly. These showed that students at the Hautes Ecoles de Commerce are not particularly bothered about the future. As they see it there are plenty of opportunities and the real issues on which they have to make up their minds are whether security, remuneration, or the interest of their work is the most important factor in choosing a job. Some of the students are inclined to favour a nationalised industry as offering a career of public service. But these are the exception.

The majority, consisting perhaps of the more worldly students, speak of the higher rewards to be had in private industry and the prospect of a much freer hand in the everyday running of the job. But, in any case, the HEC students are already committed to a career in industry by the nature of their course of studies. Some 89 per cent each year go into private industry where they become part of general management. These students are not technical men, and the main objective of their training has been to teach them to think and to apply the celebrated French logic to each problem that comes their way. From then on they have to learn as much of the technical side of their particular industry as is needed for their work by experience. This is something that happens here too.

But does the French HEC system really produce young men who are able to think for themselves? If so, this will be another of these things that are said to be ordered better in France.

New Metallurgy Chief in Steel Research

Mr. W. E. Duckworth, whose career in metallurgy has included posts with English Electric, British Insulated Callender's Cables and Glacier Metal, has been made head of the metallurgy (general) division of the British Iron and Steel Research Association.

The author of papers on powder metallurgy, fatigue, wear of metals, and on statistical and operational research subjects, Mr. Duckworth has also written a book for the industrial manager, *A Guide to Operational Research* which will be published early next year.

Joining Glacier Metal in 1949 from BICC as a research investigator, Mr. Duckworth was made manager of a research department which embraced a number of sections including an operational research section. Last year he was made manager of an operational research department.

Professor G. Wesley Austin will continue to act as consultant to the division.

Education for Emigration

The battle for a place at the university is part of the national scene and (almost) universally deplored.

It is sad to come upon a part of the universities' activities where the outcome of all the work, spending of money, and incidentally exclusion of those who did not quite make it, is to prepare men for an occupation they must either abandone or emigrate if they insist on practising.

This curious state of affairs exists in geology. In recent months about 240 undergraduates have become the holders of Honours degrees in the subject. Now the position is that the great majority of them are either signing up for overseas posts or looking for jobs outside geology.

Since the war some 2,000 geology graduates have left the universities. The geological survey of Great Britain and university staffs have recruited about 300. Many have moved into other occupations and almost all the rest are now serving overseas with mining or oil companies or with geological surveys. Some, but not all, are of course with British mining or oil interests.

Professor David Williams, President of the Institute of Mining and Metallurgy, has called on British industry to employ more geologists trained in United Kingdom universities and also to realise more fully what geology can do for it. A 1959 White Paper gave the total number of geologists employed in the UK as 843, many of them not graduates.

£250,000 for Better Factory Health

One of the last acts of Mr. Edward Heath, in his period of office as Minister of Labour, was to announce in the Commons the gift of £250,000 from the Nuffield Foundation for the further development of group industrial health and industrial hygiene services.

Health in factories is not merely a matter of keeping on the right side of the Factory Acts, as is recognised by many individual firms and by the operation of group schemes at such places as Harlow and Slough.

The group medical scheme at Slough was set up in 1947 and by last year had been joined by 193 firms with 17,638 people. Harlow began in 1955 and by last year had 44 industrial member firms with 7,455 employees. Harlow also has nine building and civil engineering member firms.

The Nuffield Foundation has sponsored the Slough and Harlow schemes and the employers pay subscriptions for the services provided.

Announcing the Nuffield gift, Mr. Heath explained that the money will be used to assist schemes which are practical and appear to promise that they will become self-supporting after a time.

One of the services that can be carried out by group health schemes and for which there is a definite need is the conduct of chemical, physical and biological tests where special hazards are feared. The Ministry is to set up an organisation for the collection of information on toxic substances in factory atmospheres and for making it known to employers.

There is some valuable information on this in the recently published Ministry of Labour booklet, *Toxic Substances in Factory Atmospheres* (HMSO, 1*s*).

Computer Fellowships Offered By Unesco

Six fellowships, normally of six months duration, are being offered by the United Nations Educational, Scientific and Cultural Organisation for research by well qualified specialists on the use of electronic computers for mechanical translation, theory of switching, or computer use for reduction of geophysical data.

Monthly allowances and a travel grant will be given according to the country in which the fellowship is taken up.

The United Kingdom National Commission for UNESCO, at the Ministry of Education, Curzon Street, London, W1, have the details. The final date for applications is 31 August.

Refinement in a New Medical Block

Practical example of the British Insulated Callender's Cable Company's interest in the welfare of the six thousand people at its Prescot Works is the new medical block now in use.

The block includes a main surgery, chiropody department, physiotherapy facilities and rest rooms. Dr. H. Holden, the medical officer, the two welfare officers and the welfare clerical staff are housed in the new centre.

The air conditioned main surgery has been designed to give an open plan lay-out. Prescot employees are encouraged to attend for proper medical treatment of minor injuries such as cuts, bruises, sprains, slight burns, which could lead to more serious trouble if neglected. This leads to the apparently rather high figure of 15,000 cases a year, but what can not be accurately calculated is the saving of time and efficiency that would be lost through inattention to the numerous minor cases.

The new block was opened by Professor R. E. Lane, Professor of Industrial Health at Manchester University.

Work-Absence Study Leads to Vernon Prize

The Vernon Prize of the National Institute of Industrial Psychology is to be awarded for research into attendance and absence from work. The winner of the 1960 prize is Dr. R. B. Buzzard of the Medical Research Council.

The prize was set up by the late Dr. H. M. Vernon, one of the original investigators of the health of munitions workers in the First World War. It is awarded for work which is judged to be most valuable in the service of industrial psychology and physiology.

The Ideal Site as a Point of Equilibrium

The optimum location for a factory or distribution centre may be determined graphically, using a procedure based on the polygon of forces.

By Jack I. Hanania, Khalil M. Malouf and Ivan A. Rubinsky
School of Engineering, American University of Beirut

AN ENGINEERING installation should be sited so as to minimise initial and operating costs. Problems of economic location, which may be concerned with water supply, transport and storage, sewage disposal, power distribution and so on, often become too complicated to treat analytically. Graphical and mechanical model methods may then be used with advantage in solving certain classes of such problems.

An example in storage location may be taken as typical of problems lending themselves to this treatment. Given several points A, B, C, D, as shown in Fig. 1, from which loads have to be transported to a central place of storage X, determine the location of X which will result in a minimum cost of transportation.

The cost of transport per unit distance may be the same for all loads or, more generally it may be different for each load. Let it be assumed that these costs are equal to p, q, r and s from each of the points A, B, C and D respectively. The solution must satisfy the relationship:

$$p(AX) + q(BX) + r(CX) + s(DX) = \text{minimum.}$$

Both analytical methods and graphical methods may be used in arriving at the required solution.

Lamé solved similar problems of location by reducing them to a problem of equilibrium. He assumed that forces p, q, r and s (Fig. 1) passing through the points A, B, C and D are acting on point X. If the magnitude of these forces is chosen so as to be representative of the given problem (for example directly proportional to total transportation costs in the example of Fig. 1), then the position of X at which these forces are in equilibrium would, at the same time, be its location for the siting problem.

It is easy to prove the correctness of Lamé's method by considering the analytical condition for the most economic location. If points A, B, C and D are given, and an arbitrary position X is selected; then AX, BX, etc., are the distances from X to the given points. Denoting them by d_1, d_2, etc., the most economical position will be satisfied by the relationship:

$$U(\text{total cost}) = pd_1 + qd_2 + rd_3 + \ldots = \text{minimum.}$$

Consider p, q, and r to be constant vectors, then the above equation would represent the expression for the potential of those vectors at point X; and all space around them can be considered as a potential vector field. The minimum potential would be obtained when the sum of the vectors is equal to 0. Where the vectors are considered as forces, the above condition would represent the position of the point X at which equilibrium is established.

The mathematical solution for minimum cost may be obtained by expressing U in terms of the coordinates, x and y, of X, differentiating with respect to x and y in turn and equating to zero. It will be apparent that if p, q, r and s are treated as vectors, having the directions XA, XB, XC and XD respectively, then their vector sum must also equal zero; and, being added vectorially, they will form a closed polygon. Where there are only three forces the Mobius theorem concerning "the centre of non-parallel forces" may be applied. A procedure whereby one of the "forces" is regarded as the resultant of the other two and its line of action determined by trial gives the position X.

A simpler method has been devised by one of the authors in which the plotting of point X was also made graphically but with the help of a tracing paper. The points A, B and C for a three-point case were plotted separately on tracing paper and three concurrent forces p, q and r drawn in their position of equilibrium, that is radiating from one point and parallel to their positions in a given triangle of forces. By placing the tracing paper over the plotted points, the lines of action of the forces could be easily made to pass through the respective points by shifting the tracing paper. This position of coincidence would determine the position of the point X. This method is similar to the one used in surveying and is much faster than the trial method based on Mobius.

When more than three points are given, another trial method may be suggested. The given points A, B, C, D, etc., are plotted, then after examining their position and taking into consideration the magnitudes of their respective associate numbers p, q, r, s, etc., we select a probable position of point X and connect it with A, B, C, D, etc. (see Fig. 1). Starting with point X a polygon is drawn with its sides proportional to p, q, r and s and parallel to the distances AX, BX, CX and DX. The closing line of this polygon would represent the sum of the plotted vectors. If it happens to be equal to zero, it signifies that the position of point X was correctly assumed, and the smaller the value of the resultant vector R, the nearer would the assumed position be to the true one. The direction of the resultant vector indicates approximately where the true point lies, and a second point is then selected and a new resultant vector obtained. Intersection of the two vectors would indicate still more closely the position of the point sought, and further trials would permit point X to be determined with sufficient accuracy.

Problems with a number of points can be very simply solved by means of a mechanical model. Such a model would consist of a horizontal table on which is placed a paper with plotted points A, B, C, D, etc. Small flat pulleys are positioned on the drawing as sketched in Fig. 2 so that threads passing round them just touch the points. All the ends are linked together at one point by means of a small ring. The other ends hang over another set of pulleys at the edge of the table and weights which are proportional to the values of p, q, r and s are hung on them. The threads, under the combined action of the forces, would then assume a position of equili-

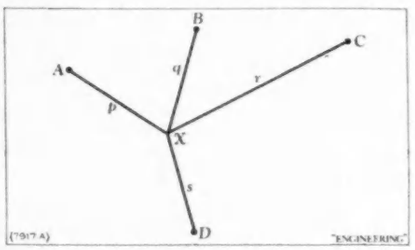


Fig. 1 Siting a depot to minimise transport costs.

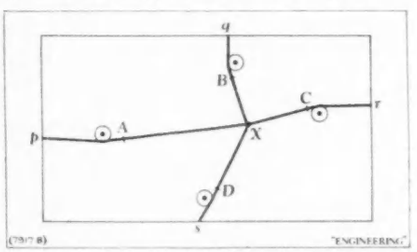


Fig. 2 Arrangement of thread and pulleys designed to simulate the siting problem.

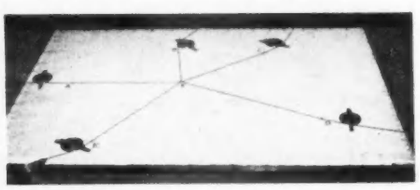


Fig. 3 Table model used for siting calculations.

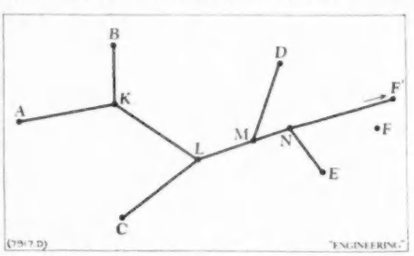


Fig. 4 Water distribution system based on a source located at point A.

Fig. 5 Example: selecting an optimum water-distribution network.

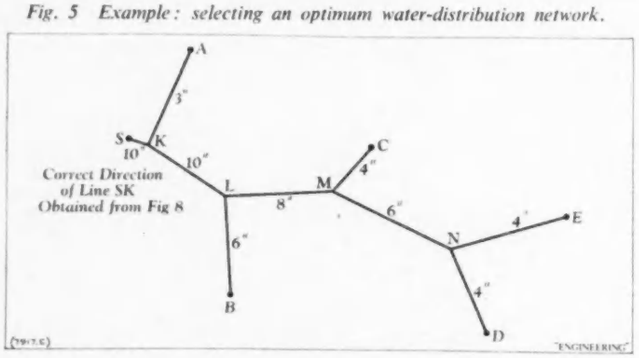
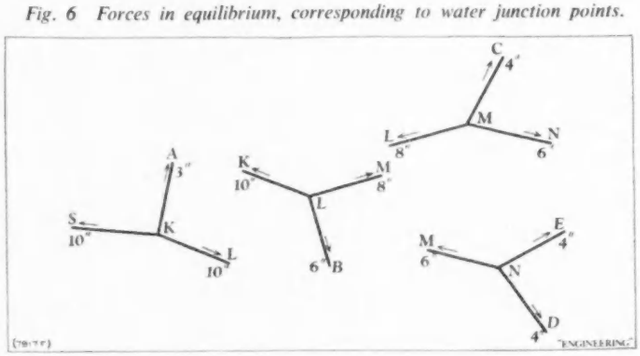


Fig. 6 Forces in equilibrium, corresponding to water junction points.



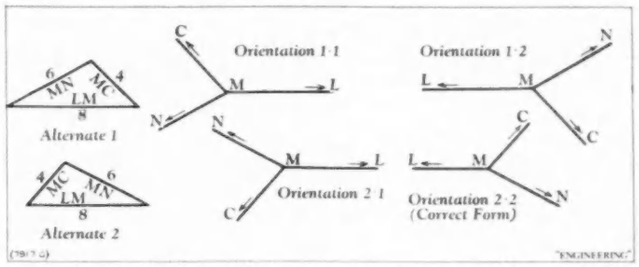
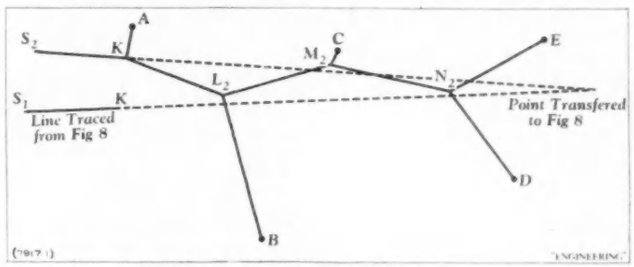


Fig. 7 Alternative solutions for equilibrium at junction point M.



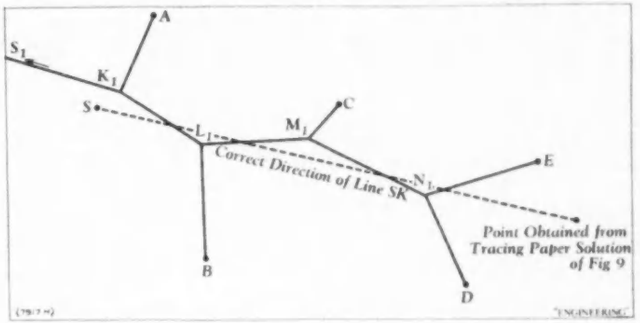
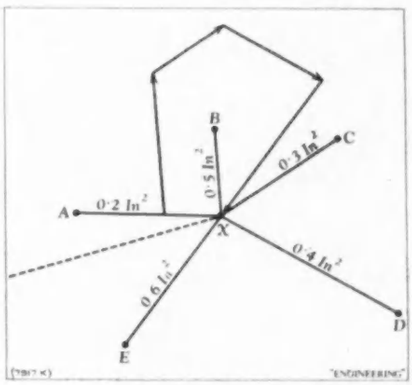


Fig. 8 (above) First trial to obtain direction of SK.

Fig. 9 (left) Second trial or tracing-paper solution.

Fig. 10 (right) Example from electricity supply based on load-centre radial distribution system.



brium, which would give the required point X.

Although it may be necessary to move the pulleys about in order to ensure that the threads pass through the points A, B, C and D, the whole operation takes very little time and the result obtained is quite accurate. In an actual model at the School of Engineering in the American University of Beirut, the pulleys used had ball bearings, and setting up a problem seldom took more than ten to fifteen minutes. (See Fig. 3.)

WATER SUPPLY SYSTEMS

For water distribution systems or similar situations, where it is necessary to lay out a branching network, the method of "trials" suggested by Lawngard and Vorgeimer may be used. Assume that the position of a starting point A is given (it may be the place of a water source or a power station) and the location of the points B, C, D, E and F (Fig. 4), which are to be supplied, and also their associated cost coefficients.

Following Lamé's Method it can be seen that at each point of branching, K, L, M and N the condition of equilibrium of the assumed forces may be expressed by closed triangles having their sides proportional to the respective costs. The geometry of Lamé's condition shows that the system has only one "degree of freedom."

The selection of the initial direction A K may be taken arbitrarily, but the others must follow Lamé's condition for each intersection until the network ends with the last direction N F′. Except for a very lucky coincidence, the line N F′ would not pass through point F, and another trial must therefore be performed changing the initial direction. This would result in an equal angular rotation of all the lines in the network. The intersection of the last direction with the previous line NF′ would then give a point which, when joined to the last location F, would determine the true direction of F N. The graphical construction is then repeated in reverse order until the point K is reached. As a check, the line K A should pass through A.

It is obvious that, once one initial construction is made, the final solution can be easily obtained by the tracing-paper method. The initial system is drawn on tracing paper, and a second trial solution obtained, giving the required direction of the line F N.

Example 1.—Towns A, B, C, D and E are to be supplied with water, each at one control distribution point, from a given source S, the locations being defined by Fig. 5. Supply requirements and hydraulic design considerations impose the pipe diameters shown on the figure. Assuming for simplicity that the total installed cost of all pipes over the whole area is directly proportional to the pipe diameter, determine the most economical network.

This is a typical case where the use of the tracing-paper method provides the easiest method of solution. The following steps may be used. (1) Complete the force triangles for all junction points. These figures are drawn by knowing the length (proportional to cost) of each side. From the force triangles, obtain corresponding diagrams of concurrent forces acting away from the junction in the correct directions indicated by the triangle and the respective locations. These are shown in Fig. 6. Care must be exercised in drawing the triangles and the corresponding diagram of concurrent forces.

For example at junction point M, equilibrium has to be established between forces of 4, 6, and 8 units of magnitude. Various solutions seem to be possible, and these are given in Fig. 7. But it is obvious that all the diagrams 1.1, 1.2, 2.1, and 2.2 are merely different orientations (or mirror images) of one and the same set of concurrent forces, and that orientation 2.2 is the only one which is consistent with the given relative locations.

(2) Starting at one end E, assume an arbitrary direction for the 4 in pipe E N.

(3) With the help of the force triangle for the junction point N, drawn on the tracing paper, locate point N_1. This is done by making lines N E and N D pass through points E and D, respectively. The direction of N_1M_1 is therefore established.

(4) Use the force triangle for the next junction-point M, and hence determine the location of M_1 and the direction M_1L_1. Repeat until the line K_1S_1 is obtained (Fig. 8).

(5) Place a tracing paper on top of the obtained system and draw on it the final line K_1S_1 (last line of Fig. 8). Also plot points A, B, C, D and E. Keeping point E fixed, turn the tracing paper through a small angle and fix it in this position.

(6) Trace the first assumed direction E N_1 on to the tracing paper. Then from D on the tracing paper draw a line parallel to D N_1 to obtain a corresponding point N_2. Continue until a complete new network is drawn on the tracing paper. This will end by another line K S_2. Determine the point of intersection of this line with the final direction line K S_1 obtained in the first trial of Fig. 8, as indicated in Fig. 9.

(7) Transfer this point of intersection to Fig. 8 and join it to the point S. This gives the required direction of the line S K which will result in the most economical network.

(8) Use the force triangles drawn on tracing paper and repeat the initial construction starting from junction point K. As a check the final lines should pass through points D and E. The correct solution is the one shown in Fig. 5.

The above problem can also be used to illustrate the application of the method to electrical power distribution. Thus, S may be looked upon as a generating station or a substation feeding the load points A, B, C, D and E. The system would then be a typical case of the simple radial distribution system, commonly used in rural electric distribution. Electrical considerations, such as the various power load demands, voltage regulation requirements at the load points and the current-carrying capacity of the conductors, would then determine the cross-section of the conductors between S and the load points. It may then be assumed that the total cost of the installation per unit length is directly proportional to the conductor section. Accordingly, force triangles are drawn at each of the tap points K, L, M and N, with the force vectors representing the conductor section. The tracing-paper method, as used in the hydraulic problem, will then yield the optimum location for each of the tap points.

ELECTRICITY DISTRIBUTION

Example 2.—Another type of electrical distribution problem that lends itself to solution by the methods outlined in this article is the case of the load-centre radial distribution system. An example of this type of problem is represented in Fig. 10. A, B, C, D and E are five load points to be fed with different amounts of electric power from a load centre X. The main which feeds X from the source of supply is shown dotted in the diagram, and has no bearing on the present problem. Electrical design considerations necessitate the use of conductor sections as shown. The problem may be reduced to determining the location of the load centre X which will yield the most economical system. Two methods of solution are suggested.

In the graphical method employing the polygon of forces, a position for X is chosen at random. The force polygon is drawn, with sides parallel to X A, X B, etc., and magnitudes proportional to their cross-sections, and the error observed. Successively more accurate polygons are drawn, until the correct position for X is reached which yields the polygon closing on itself. This polygon is illustrated in Fig. 10, and the point X marked there represents the optimum location of the load centre. The mechanical model may also be used to solve the same problem, and results obtained from the model described previously (Fig. 3) have shown close agreement with those deduced by the graphical method.

Fire Endurance of Timber Structures

Fire damage to any building fabric does not reach serious proportions until the chance of human survival is practically zero. Timbers have the virtue of not collapsing quickly with temperature rise. Nor does timber burn easily.

By H. Richardson, A.I.W.Sc.

Industrial Relations Officer, Timber Development Association

WHAT is the main point in protecting a building from fire disaster—preserving its production facilities, raw materials, finished goods, sales records or the shell of the building?

The financial value of a building is often only a fraction of that of the contents of such buildings. In the case of those industries manufacturing costly products and making use of expensive capital equipment the ratio of content cost to structural cost may be as high as 50 to 1. The same considerations apply in such structures as aircraft hangars. In spite of this it is not often recognised that factory buildings are themselves a factor in fire safety.

Because of the nature of most industrial operations outbreaks of fire can never be wholly prevented. Consideration must therefore be given to the technique of structural fire protection and to the provision of adequate escape routes for operatives endangered by fire. Design and construction must both play their part in providing the maximum degree of safety and protection.

RISK FACTORS

At the same time it must be recognised that we are entering the age of large buildings. Industrial operations can no longer be carried out conveniently or economically in confined spaces; automation and conveyor lines are imposing a discipline on factory design which cannot be ignored. These wide spanning structures often mean that fires have to be fought within the hearts of large buildings and, not unreasonably, the fire fighter is demanding that he shall be able to do so in comparative safety.

These considerations must inevitably lead to the conclusion that more attention must be paid to the fire durability of the structure and, setting aside problems of design and construction, the properties and endurance of the materials of construction when exposed to fire.

In spite of the many claims which have been made, no building is fire proof. All can be damaged by intense heat. The fire endurance of building materials is merely a matter of time and temperature. But because timber will burn it is looked upon as a hazard in building and no attempt is made to evaluate its performance in engineered structures and to compare these properties with those of other materials.

After two years of research on fire safety the Canadian Institute of Timber Construction came to two main conclusions. These are:

1. That the role of building materials in fire safety has been magnified out of all proportion to its true importance.
2. That the essential requirements for real fire safety in a timber building are equally necessary in other types of construction.

The basic question remains: what has to be protected in a building—the occupants—the business operation—the structure—or all three? To put these objectives into proper perspective, the heat vulnerability of people and materials must be properly understood and the appropriate protective measures applied.

In considering the life safety of the occupants of a building the most important single factor in case of fire is prompt detection. Any delay in detection can endanger the occupants in a matter of minutes and most building materials, including timber, would not even be ignited at temperatures which are critical for human survival. The principal danger to life, therefore, arises from the gases generated by the contents and equipment of the building in the initial stages of the fire.

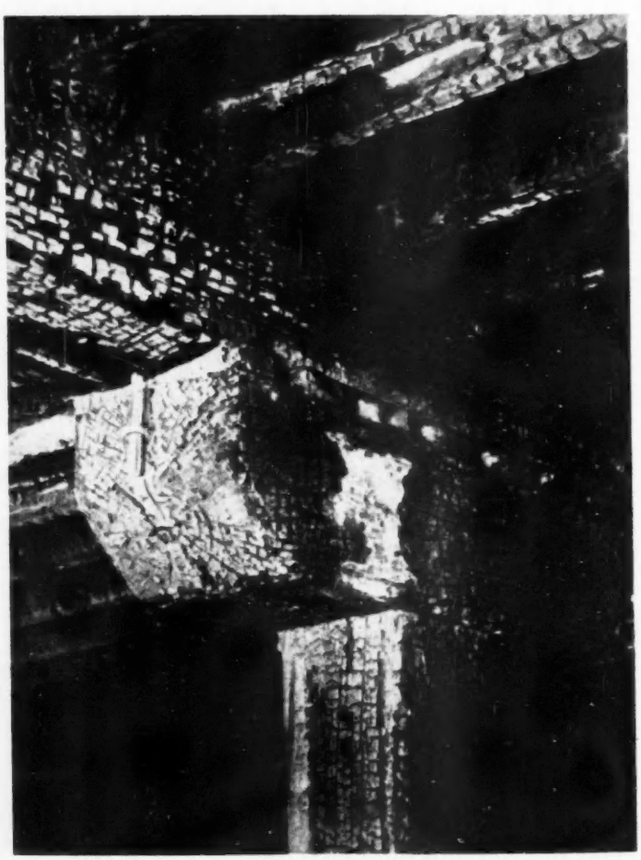
Against this hazard, where every minute is of vital importance, adequate alarm and exit facilities are the main line of defence and, provided these exist, structural fire endurance has little bearing on life safety. Fire damage to buildings does not reach serious proportions until some time after the chances of human survival are practically zero.

Almost all fires originate in the contents and not in the structure. Susceptibility to ignition and heat damage is more likely to be found in the ancillaries to industrial processes rather than in the materials of construction, which require varying amounts of heat to convert them to gases before ignition can take place and before the material can support combustion. The amount of heat required will depend to a large degree on the type and size of the object attacked by heat. The contents of the building on the other hand are often present in less compact forms and only small amounts of heat are necessary for to bring about ignition.

TINDER DEFINED

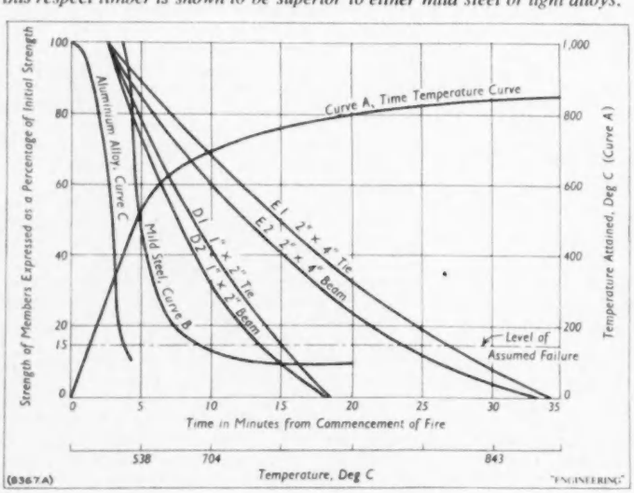
In general, fires must start in tinder, in which the ratio of exposed surface area to mass of material is sufficiently high for self-supporting combustion, even when moderate heat is applied over a very small area. A more precise definition of tinder is that it has a specific surface of more than 20 square centimetres per gram of combustible material.

Most of the normal contents of a building fall into this tinder class, but wood in dimensions ordinarily associated with building materials has a specific surface that is only a very small fraction of that of tinder. Common experience will support the view that wood is not a suitable



Contrary to widely held belief, timber in structural sizes does not readily burn. It does char, though at a comparatively slow rate, with a consequent reduction in the area of the cross section.

The graph illustrates (curve A) the rate at which temperature can increase following the commencement of a fire and, in the other curves, the way in which the strength of different materials falls with rising temperature. In this respect timber is shown to be superior to either mild steel or light alloys.


Strength of Members Expressed as a Percentage of Initial Strength
Temperature Attained, Deg C (Curve A)
Curve A, Time Temperature Curve
Aluminium Alloy, Curve C
Mild Steel, Curve B
D1 1" × 2" Tee
D2 1" × 2" Beam
E1 2" × 4" Tee
E2 2" × 4" Beam
Level of Assumed Failure
Time in Minutes from Commencement of Fire
Temperature, Deg C
(8367-A)
"ENGINEERING"

material for starting fires until it is reduced to tinder size.

Rapid flame spread is associated not so much with the structure as with the contents or with continuous linings of combustible material having a high specific surface. The importance of the structure itself lying chiefly in its fire endurance, that is to say, in the period for which it will withstand a prescribed heat and load without collapse. In this respect, timber behaves better than unprotected metals, as can be seen in the accompanying graph. It cannot be emphasised too often that damage from premature building collapse can be a lot more serious than having combustible structural framing.

No building material is immune to fire damage, each has its own peculiar properties when exposed to conditions of severe heat. Steel loses strength as its temperature rises above about 250° C; at about 550° C it has a little less than half its original existing strength and loses 90 per cent of its strength at about 750° C. Concrete is damaged by heat and spalls and cracks. Most aluminium alloys start losing strength immediately the temperature is raised: they are reduced to about half their strength at 300° C and melt at about 600° C. These temperatures are significant when it is realised that ordinary building fires attain temperatures of from 700° C to 900° C. Wood does not lose strength in the same way; in fact its unit strength may increase with increase in temperature, owing to the reduction in moisture content; a wooden member loses strength by reason of the material lost through the charring of the surface. It does not ignite until a temperature of about 250° C is attained, and thereafter chars about 1 in of depth in 40 minutes at normal fire temperatures.

The metals have a high thermal conductivity and consequently the dimension of structural members made of steel or aluminium have little bearing on their fire resistance; this is not the case with timber, because wood has a low thermal conductivity, the thicker the member the less heat there will be to liberate inflammable gases in the middle of the timber and the less danger there will be of the timber burning through.

In addition, metals readily expand under the influence of heat. This gives rise to severe side pressures in masonry walls, leading to fracture and subsequent collapse of walls, floors and roofs, perhaps without warning. The threat of such sudden building collapse is a severe hindrance to fire fighting and may prevent effective action within the building. War time experience showed that walls of sufficient resistance to contain fires successfully have been pulled down through the distortion of incombustible roof structures, while timber roofs have in many cases left the walls unharmed.

Curve A on the graph is a time-temperature curve and is devised, as far as possible, to be analogous to the conditions obtaining in a building fire; the ordinates (with scale on the right-hand side of the graph), indicating the temperatures attained at any given time after the commencement of the fire.

The ordinates of curve B show the strength of mild steel—expressed as a percentage of the ultimate breaking strength at normal temperature—at the temperatures attained at different times after the commencement of the fire. Curve C gives the same information for a typical aluminium alloy. The data upon which curve B is based are taken from a paper "Effect of Temperature on the Modulus of Electricity and other Proerties of Metals" presented by Professor F. C. Lea to the Institution of Civil Engineers (*Proc. Inst.C.E.*, vol. 209, 1921).

From what has been said earlier, it will be clear that comparative figures for timber can be given only in respect of members of specific sizes. Further, as the information given relates only to tensile tests for breaking strength, the comparison must be limited to members for which this is a criterion, i.e. ties. Curve D is calculated to show the effects of the depletion of cross-section corresponding to charring at the rate of 1 in in 40 minutes for a 2 in by 4 in tie.

STRUCTURAL COLLAPSE

Taking into account factors of safety normally employed in design, the failure of fully loaded ties would not occur until the strength value dropped to about 25 per cent of the original. Comparing results at this level, it is found that times taken to reach failure are as follows:

Aluminium alloy	about 3 minutes
Mild steel	about 6½ minutes
Softwood	about 29 minutes

From this it is clear that in buildings of a class for which unprotected steel or aluminium are acceptable, softwood of a minimum thickness of 2 in will afford a vastly superior measure of fire endurance. To meet more rigorous requirements, fire retardant treatment and/or greater thicknesses of material, are the obvious remedy. For instance, where columns and beams are required to have a fire resistance of one hour, it is often provided by encasing steelwork or reinforcement with the minimum thickness of from 1 in to 1½ in of concrete. It seems clear from the foregoing that a fire endurance of one hour can be assured at less cost by a softwood structure, provided the thicknesses used are not less than 4 in. Additional fire endurance can be obtained by increasing the cross-sectional area of the timber components.

Structural collapse adds to the difficulties of fire fighting; increases the damage to the contents; and reduces the salvage value of the building shell, the capital equipment and stocks. The fire endurance of timber structures is generally very considerable. In spite of this, whenever timber is suggested for use in a structure, the fact which tends to be considered to the exclusion of all others is that wood burns whereas other structural materials do not. Yet timber structures under fire will generally fail less quickly than comparable structures of unprotected metals or prestressed concrete structures, both of which fail quickly and completely from the effects of heat alone.

There have been many heavy fire losses where all the building materials were incombustible. The loss of strength and excessive distortion of metals under heat action are the cause of many building failures. In short, fire resistance is a property distinct from combustibility and must be considered separately. Plainly the terms "fire resistance," "combustible" and "incombustible" when applied to construction should mean more than just resistance to fire consumption—they should also include the effect of heat on materials which causes distortion and reduction of load carrying capacity.

A timber structure is often regarded as contributing combustible matter to an existing conflagration. It is in this respect that a sense of proportion is essential. To assist in this, reference is made to the conception of "fire load" as defined by the Joint Committee on Fire Grading of Buildings. The term is used to describe the number of British thermal units which could be liberated per square foot of floor area of a compartment by the combustion of the contents of the building and any combustible parts of the building itself. It is determined simply by multiplying the weight of all combustible materials by their calorific values and dividing by the floor area under consideration.

From data obtained from a number of sources, the Joint Committee found that the fire load of residential buildings, hotels, hospitals, schools, offices and similar occupancies did not exceed 100,000 Btu per sq. ft. This they designated as *low* fire load. This figure provides a useful yardstick to measure the contribution of timber construction. For a building with a span of, say, 50 ft, the amount of timber in the roof, including trusses, purlins and bracing, would not exceed about 2 lb per sq. ft. Taking the calorific value of wood at 8,000 Btu per lb, this is equivalent to a fire load of 16,000 Btu per sq. ft, or less than one-sixth of what has been defined as a *low* fire load. At the other end of the scale, a very high fire load might be as much as four or five million Btu per sq. ft. In such a case, the timber roof might be adding something less than half of 1 per cent to the fire load.

To sum up, it is submitted that a structural timber framework, designed on sound engineering principles, is at least as good a fire risk as an unprotected metal structure.

In sound fire protection practice there are four basic requirements: the safety of the occupants, the contents, the business and the structure. It is difficult to find one solid fact which precludes the use of timber on any of these grounds.

Superstructure Begun on the Forth Road Bridge

Work on the new Forth road bridge has reached the point where, with the substructure (including the foundations and the anchorages) virtually complete, the first steelwork of the superstructure has been put into position.

This first item of steelwork consisted of the base sections of the north main tower—two outer sections weighing each 17½ tons and an inner section of 15 tons. The illustration shows the first section being lowered on to the holding down bolts on the pier.

All but 2 ft 7 in of the bases of the towers on the north and south piers will be bedded in concrete and both towers will be built up to a height of 505 ft above sea level. The manufacture of the towers was described in ENGINEERING for 20 May last (vol. 189, p. 688). Each tower comprises two towers made up of 33 welded boxes of high tensile steel, each about 47 ft 6 in long, up to 12 ft wide and 5 ft deep, and having a maximum weight of 34½ tons. After cleaning by grit blasting, followed by metallisation and painting, the sections will be lifted by climbing crane and bolted together to form the towers. In all, 132 sections will be used. Transport to the site, metallisation and erection of the tower sections will continue over the next few months and it is expected that a major part of the tower steelwork will be completed by the end of the year. Then will begin the work of spinning and anchoring the cables, and erecting the decking.

The Forth road bridge, with its span of 3,300 ft between the towers and side spans of 1,340 ft each, will be the longest suspension bridge in Europe. Mott, Hay and Anderson, in conjunction with Freeman, Fox and Partners, are the consulting engineers, and the late Sir Giles Gilbert Scott was the architect. The contractors for the foundations and anchorages for the main span are John Howard and Company Limited and the superstructure is being fabricated and erected by the ACD Bridge Company.

Lowering the first base section on to the holding down bolts on the north pier, with the famous Forth railway bridge in the background.

Saharan Oil Goes to Market

State participation in many private exploration companies, and the wide distribution of financial risks, introduce a new competitive element into the French oil industry which may force out the international companies.

THE FRENCH Government has recently moved into the oil business in a big way. The central state-controlled organisation for this purpose is the Union Générale des Pétroles which has been given the job of transporting, refining and distributing Saharan oil in France.

The financial set-up is complicated. The UGP will be owned by the Régie Autonome des Pétroles, the SN Repal and other state-controlled companies concerned with oil in French Africa. The initial capital of UGP is reported to be only about £10 million, of which French state-participation accounts for around 60 per cent and the rest represents a controlling interest of the French affiliate of Caltex. The Bordeaux refinery of Caltex and its distributing system in France becomes, in effect, part of the State network. The refinery treated just over one million tons of crude last year and the Caltex pumps handled rather less than 4 per cent of all French retail sales.

The 60 per cent of the French share of the capital is quite simply split three ways. About one-third is held by the body responsible for administering oil research and production, the Régie Autonome des Pétroles, whose principal officials take charge of UGP. Another third goes to SN Repal, the state-owned body which has a half share in the oil and gas wells of Hassi-Messaud and Hassi-R'Mel in the Sahara. The rest is held by four companies under the control of the state-owned Bureau de Recherches de Pétrole. These four include the Acquitaine Company which is now exploiting the natural gas field at Lacq in south-west France.

That briefly is the framework within which State enterprise is now operating in the French petroleum industry. Its ramifications are extremely complicated and are carried on by a number of holding and finance companies known as REPs. The three initials stand for RE-cherches Pétrolières.

TAX FREE ENTERPRISE

The first REP was formed at the end of May, 1954, under the auspices of three banks—the Banque de Paris et des Pays Bas, the Crédit Commercial de France and the Crédit Lyonnais. Two oil companies, Antar Pétroles de l'Atlantique and the French BP were also involved. The new concern was called Finarep. Essentially, Finarep is a holding company with a difference. The difference is that its profits are tax free, interest on money invested is guaranteed by the State and it can call on the resources of the official Fonds aux Soutien Hydrocarbures. Setting up of Finarep had to be approved by special decrees both of the Ministries of Finance, and of Industry. The activities of Finarep are spread through a number of companies and organisations engaged in the search for, or production of, oil in France itself, Algeria, Tunisia and Morocco. But all this is the straightforward side of the story. The tie-ups between Finarep and other state-controlled bodies are, to say the least, somewhat involved. Finarep holds 20 per cent of the capital of REPGA, and 10 per cent of a long list of companies including Pétrorep, Safrep, Cofepa, Coparex, Omnirex, Péchelbronn-REP and Petrosarep.

The wide range of these holdings and their small size means that Finarep is linked to a large number of bodies without in any way controlling them. The holding of shares and the voting rights attached to them is strictly regulated in all the REPs. The fact that the State has guaranteed a minimum dividend of 5 per cent right up to the end of 1967 has, however, made them an extremely popular proposition on the Paris bourse. Finarep shares, issued at 10NF in 1956, now stand at 15NF. With the capital it has obtained from its various issues Finarep has bought an interest in other concerns in the oil business. These include SNPA, Esso-REP, CREPS, and others operating in Gabon and the Congo.

The basic principle for the management of the REPs is the wide spreading of risks in a financial, geographical and political sense. Although Finarep is the oldest, three other Reps are generally bracketed with it as being leading organisations in the petroleum industry. These are COFIREP (Compagnie Française de Recherches Pétrolières), GENAREP (Compagnie Générale de Recherches Pétrolières) and REPFRANCE (Compagnie Francaise pour le Financement de la Recherche et l'Exploitation du Pétrole). All of these hold shares in the same group of state-controlled producing and exploration companies. The big oil finds in the Sahara have greatly increased the value of these concerns. They have also made the directors of the REPs more ready to invest in new companies working in areas that have not yet produced any very definite signs of oil or natural gas. The fact that holdings are small means that no one concern stands to lose too heavily if hopes are not realised.

One interesting feature of the REP technique is that it enables the State to participate in what is essentially a private company. Pechelbronn-Rep for example has Pechelbronn, the mining and development company, as its main shareholder, but Finarep, Cofirep, Generep and Repfrance all have 10 per cent holdings.

The main task of the UGP and its constituent parts is the refining and marketing of Saharan crude. The Caltex refinery and distribution system will clearly not be adequate to carry out the whole task. At the present time it is not clear how the oil companies will fit into the general picture. Four principles have been laid down by the Government for the marketing of Saharan oil. These are—

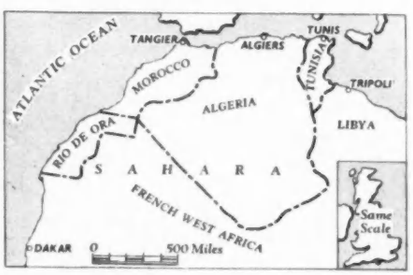
(1) Oil produced in the franc zone must for the most part be sold in the franc zone.
(2) A "sufficient share" of the French market must be left to those companies which had set up modern refineries and distribution systems in France before the Saharan discoveries.
(3) These companies will be invited to enter into contracts with the producers of oil in the franc zone, so that "a reasonable share of the country's supply should be reserved for each of the sectors of franc zone production . . . whatever the pattern of traditional imports may have been."
(4) The UGP will be free to compete commercially with the established distributors without any discrimination in its favour.

All this certainly means increased competition in France. The French technicians are clearly sold on the view that the industry must expand and that there must be no slackening off in the search for oil in French territory. The idea of possessing abundant energy is one that has a special appeal in a country which was short of coal when that fuel was the leading energy source. But perhaps the biggest factor in the situation is the desire to use Saharan oil and gas in the industrialisation of Algeria. The rapid raising of living standards in North Africa through industrialisation is the key factor in French policy. But it would clearly be unwise to develop franc zone oil at the cost of antagonising the international oil producers, especially the Americans. Even the ingenious system of finance by REP is not likely to produce all the capital necessary for development. Some outside capital will be required. The UGP may have produced a neat solution of the problem of State participation in the oil industry, but there remains the much harder task of backing out of commitments with the international companies without offending their Governments. This, together with the political problems to be solved in Algeria, add up to a considerable headache for the French Government.

Some Petroleum Exploitation Companies in which French State and Private Capital Participate

Organisation	*Capital in N.F.*	*Some Shareholders*	*Percentage*
CAREP—Société Algérienne de Recherche et d'Exploitation Pétrolières	10,000	SN Repal	33
		Algérie	20·02
		BRP	14·43
		Confirep	5
		SNIP	4·97
		Others	22·58
Esso-REP—Société Esso de Recherches et d'Exploitations Pétrolières	35·1 millions	Esso Standard SAF	89
		BRP	5·45
		Finarep	1
FRANCAREP—Compagnie Franco-Africaine de Recherches Pétrolières	125 millions	Saint-Gobain	1·60
		Finarep	3·98
		Repfrance	3·70
		Rothschild	1·44
		Lambert	1·28
		Worms	1·22
		Cofimer	2·40
		Genarep	1·17
		Confirep	7·60
SEREP—Société de Recherches et d'Exploitation des Pétroles du Cameroun	94 millions	BRP	54·7
		Finarep	10
		Confirep	5
CREPS—Compagnie de Recherches et d'Exploitation de Pétrole au Sahara	200 millions	RAP	25·5
		BRP	4·5
		Repal	4·87
		Finarep	1·63
		Confirep	3
		"Shell" Sahara	32·375
SN REPAL—Société Nationale de Recherche et d'Exploitation des Pétroles en Algérie		Algérie	40·51
		BRP	40·51
		Confirep	5·33
		Genarep	4·09
		Finarep	3·78
		Repfrance	2·78
		Banque de France	0·45
		Cofimer	0·53

Success with Saharan oil exploration has injected a new vitality into the French oil industry.



Private Enterprise

UNIQUE research and development facilities at the Nuclear Research Centre of C. A. Parsons and Company Limited, are being brought to bear on advanced techniques having wide technological implications in nuclear power generation plant. Work is undertaken for the parent company, for The Nuclear Power Group (TNGP) and its member companies, for the United Kingdom Atomic Energy Authority and for other government and industrial concerns, both in Great Britain and abroad. Dr. B. C. Lindley, leader of the Future Studies Section, reports on some aspects of the research programmes related to four classes of reactor: natural-uranium fuelled; advanced thermal types; the high-temperature gas-cooled system; and the fast reactor.

Natural Uranium Fuelled Reactors

Considerable effort has been devoted to the performance of the metallic-uranium magnox-clad fuel element. As is well known, the result was the polyzonal spiral fuel element which has been adopted for all the present generation of CEGB reactors and for the similar reactors being built in Italy and Japan

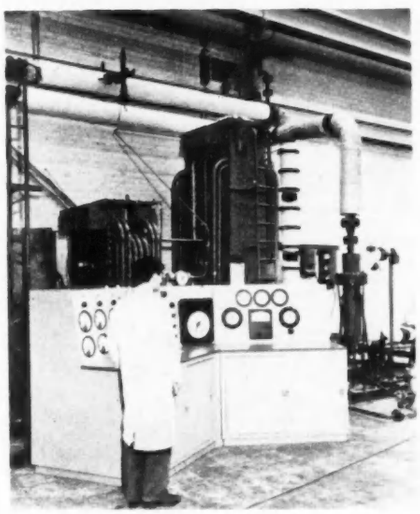


Fig. 1 Steam-cooled test facility for 400 lb per sq. in, 900° F, 8,000 lb per hr mass flow.

(H. L. Ritz: "The Polyzonal Spiral Fuel Element," Geneva, p. 48). Although these reactors represent a considerable advance in design from the original Calder Hall concept further gains are possible while retaining the same fuel and cladding materials. Continuing intensive development is taking place based on variations in geometrical configuration, and improvements in the heat transfer performance have been incorporated in the elements specified for the CEGB Dungeness station, the contract for which was recently awarded to TNPG.

Improvements in Metallic Fuels

Metallic uranium fuel will be used throughout the life of the present large-scale power reactors; that is, for at least the next two decades. The mechanisms affecting the permissible power rating and operating life are not yet fully understood. The damage due to neutron irradiation may be reduced, for example, by careful control of the structure and by alloying. To investigate such effects an irradiation programme has been prepared, in consultation with TNPG, and it is proposed, in collaboration with AGIP—Nucleare and CNRN, that facilities available in the Italian ISPRA-1 reactor should be utilised. This reactor is of the Argonne CP-5 type, moderated and cooled by heavy water; the unperturbed maximum thermal flux is 5×10^{13} neutrons per sq. cm per sec with a corresponding power of 5 MW. The initial programme will consist of an investigation of the two primary effects of the neutron bombardment of uranium metal: growth and swelling. Growth is the overall change in shape which shows a maximum at around 200° C and is negligible at above 500° C, there being little change in density during the process. Swelling occurs at above 400° C and is due to the formation of bubbles of fission product gases (predominantly xenon and krypton) and the subsequent expansion of these gases within the uranium lattice, a significant decrease in density accompanying this process. The effects of thermal cycling, grain size and alloying on the growth at 200° C and swelling at 550° C will be studied.

Advanced Reactor Types

A number of reactor systems are currently being investigated to enable the type of reactor which will succeed those now being built to be selected. Some of the possibilities are variants of the advanced gas-cooled reactor (AGR), an experimental version of which is now being constructed at Windscale, and the steam-generating reactor. Teams at the Nuclear Research Centre are engaged on theoretical and experimental work connected with these systems.

The characteristics of the reactor coolant play an important part in determining the power density in a reactor core and, among others, two-phase coolants could have a major bearing on reactor development bringing reductions in capital cost.

Two-Phase Heat Transfer

Gas as a reactor coolant suffers from two fundamental disadvantages: the low heat transfer coefficient requires the use of high velocities, and the low specific heat the use of high pressures. The performances of a suspension of fine solid or liquid particles in a gas is considerably better than that of the gas alone, since both the heat transfer coefficient and effective specific heat are increased. Experimental work has been carried out with suspensions of graphite powder in carbon dioxide and on the effect of spraying water into a simulated steam-superheating reactor channel. The effect of particle or droplet size on the mechanism of heat transfer at the surfaces of the fuel element and within the suspension will be further investigated with the rig shown in Fig. 1. The problem is complicated in one case by the reaction of graphite and carbon dioxide at high temperatures; the provision of an alternative large active surface for the $C + CO_2 \rightleftharpoons 2CO$ reaction by the graphite suspension in the coolant could have the effect of reducing mass transfer of graphite from the reactor core. In the case of liquid droplets the effect of complete evaporation within the reactor channel has to be considered.

High-Temperature Gas-Cooled System

A later stage in power reactor development will be based on a high temperature gas-cooled reactor; a number of concepts are being investigated with particular emphasis on proving fuel elements and materials for operation at very high temperatures under reactor conditions. Work is in progress for the Dragon high-temperature reactor project now under construction at the Atomic Energy Establishment, Winfrith, Dorset. The heat transfer and pressure loss characteristics of fuel elements basically similar to those for the Dragon project, but with different forms of gas channel and extended surface, have been obtained. Details of the Dragon seven element experimental plant, due to be commissioned at the Nuclear Research Centre by the end of 1960, have already been given (Atomic Review, 3 June '60). In this plant seven full sized electrically-heated fuel elements will be operated under reactor conditions of temperature, pressure and heat output. By the time the specification of the reactor has to be frozen, this plant will have provided advance information about the performance of the selected core design, the operation of the circuit and the reliability of the components under normal and emergency conditions. A continuing programme will provide further data.

Randomly Packed Pebble Bed

All studies and actual designs of fuel elements have to date been based on the concept of individual charge and discharge of the fuel rod cluster or assembly. An attractive way of increasing the surface area of the fuel element and at the same time allowing flexibility in charge and discharge is to use fuel spheres in lieu of rods or clusters. The heat transfer properties of a randomly-packed bed of spheres enable outlet gas temperatures closely approaching the maximum surface temperature to be achieved for acceptable pressure loss. By a suitable choice of diameter the heat conduction temperature drop within the fuel at high ratings can be kept low enough to prevent excessive fuel temperatures, without the mechanical complications which accompany such alternative forms as thin plates, clusters of slender rods or thin annuli. A regenerative method has been developed for obtaining the heat transfer performance of randomly packed sphere beds. Indirect tests are necessary on account of the difficulties of simulating internal nuclear heating and of measuring mean surface temperatures. Under test two sphere beds, placed on each side of a heater as shown in Fig. 2, are used as regenerative matrices. Gas is blown through the system in alternate directions, the flow direction being reversed at a controlled frequency. Mean surface temperatures and heat transfer coefficients can be deduced from gas temperature-time curves. Results have been obtained for spheres of small diameter and at low Reynolds numbers; modifications of the system, to obtain performance data for spheres of larger diameter (from 0·5 to 2·5 in) and at high Reynolds numbers, are being studied.

If nuclear reactors operating at temperatures higher than are acceptable by rotating machinery in steam or gas turbine plant become feasible, direct generation techniques are attractive; these methods for electricity production are being studied.

Ceramic Cladding and Matrix Materials

The requirements of ceramics for use as cladding or as a matrix for dispersion-type nuclear fuels are

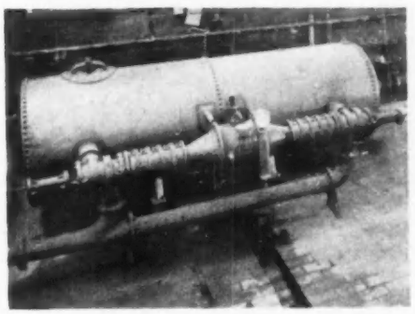


Fig. 2 Regenerative heat transfer rig for two randomly packed spherical fuel beds.

exacting. Compatibility with fuel and coolant, strength at high temperatures, high thermal conductivity and good thermal stress resistance are essential; low neutron absorption is desirable. Refractory carbides have high thermal conductivities and high resistance to thermal stress. The majority of carbides have melting points greater than 2,000° C and are difficult to sinter; the usual method of fabrication has been to incorporate a bonding material, for example cobalt, in cemented tungsten carbides and clay in silicon carbide refractories. For this reason the intrinsic mechanical properties of carbides have seldom been determined, the values obtained being influenced by the bonding material.

Silicon Carbide

As a potential high temperature reactor material silicon carbide, on account of its high thermal conductivity, low density, low neutron absorption and compatibility with the possible coolants (including carbon dioxide and steam), is of considerable interest. In common with other carbides fabrication is difficult; silicon carbide decomposes without fusion and even at 2,000° C sintering gives low density material. Methods of fabricating high density self-bonded silicon carbide, including hot-pressing and silicon-impregnation, are being developed. The mechanical properties of silicon carbide are compared with other ceramics in Table I; the final column shows the calculated heat flux-rupture limits for steady heat transfer, from which it can be seen that the performance, for the same thickness of material, is only exceeded by graphite. Since silicon carbide is considerably stronger than graphite much thinner sections can be used.

Fast Reactor Fuels

Fast reactors are important in the economic development of nuclear power on account of their ability to make the most efficient use of plutonium fuel produced in the large natural uranium reactors. A fast reactor core is characterised by an exceptionally high power density, necessitating fuel of thin section and large surface area for heat transfer, unless the permissible maximum temperature in the fuel can be

TABLE I.—*Properties of Silicon Carbide Compared with Other Ceramics*

Material	Temperature, °C	Thermal conductivity, k Btu in per sq. ft hr °F	Tensile strength† σ lb per sq. in	Coefficient of expansion, $\alpha \times 10^{-6}$ per °C	Modulus of elasticity, $E \times 10^{-6}$ lb per sq. in	Limiting heat flux* $q \times 10^{-6}$ Btu per sq. ft-hr
Beryllia, BeO	1,200	96	4,000	9	21	22
Alumina, Al_2O_3	1,200	17	18,000	8	40	10
Silicon carbide, SiC:						
Clay-bonded	1,200	100	2,000	4·7	10	47
Hot-pressed; density 3·10 gm per cc	800	175	60,000	3·9	65	440
Silicon-impregnated; density 3·10 gm per cc	600	400	24,500	3·9	65	410
	800	330	24,500	3·9	65	330
	1,200	260	25,000	3·9	61·5	290
Graphite‡	600	200	3,200	5·2	0·9	1,460
	800	175	3,200	5·6	0·9	1,190
	1,200	140	3,200	6·3	0·9	840

* Calculated for flat plate: $= \frac{2k\sigma(1-\nu)}{\alpha E t}$ where ν is Poisson's ratio (assumed constant at 0·25); t is the thickness of material taken as 0·25 in.

† Based on modulus of rupture values.

‡ Typical high strength fine-grained material.

raised above that of metallic forms. Uranium monocarbide is an attractive fuel for such highly-rated reactors, because of its high melting point, high density, good thermal conductivity and compatibility with liquid sodium, which is the most probable choice of coolant. A comparison between metallic uranium, uranium oxide and uranium carbide is given in Table II. There is therefore considerable interest in extending the data on the physical and chemical properties of carbide fuel and, in association with the UKAEA Dounreay Establishment, techniques for producing suitable specimens are being developed. Fabrication by the normal methods used in ceramic manufacture (that is, cold pressing and sintering, or hot pressing) does not normally yield a product of sufficiently high density.

Approaching Theoretical Density

A skull-casting process has been developed which produces sound specimens with greater than 98 per cent theoretical density. The carbide is arc-melted in a tilting water-cooled copper crucible and poured into a pre-heated graphite mould. Physical and chemical properties are being measured and, in particular, the effect of varying the carbon content on the thermal conductivity and thermal stress resistance is being studied. Fig. 3 shows the mictostructures of material with different carbon contents; (*a*) has too much uranium and (*c*) too much carbon, and either would produce undesirable effects on irradiation; (*b*) is the chemically-correct structure.

TABLE II.—*Comparison of Alternative Uranium Fuel Forms*

Property	Uranium	Uranium oxide	Uranium carbide
Uranium density, gm uranium per cc	19·0	9·7	13·0
Thermal conductivity at 600° C,* cal per sec cm °C	0·08	0·008	0·06
Melting point, °C	1,130	2,750	2,350
Maximum operating temperature, °C	600†	1,500‡	1,000§
Permissible heat output in rod form (independent of diameter), kW per ft	25	10	60
Compatibility:			
Sodium	Good	Poor	Good
Oxodising gaseous coolants	Poor	Good	Poor
Water	Poor	Good	Poor
Organic	Good	Good	Good

* Unirradiated.
† Determined by α-β phase change at 660° C.
‡ Determined by fission gas release.
§ It is known that fission gas release is certainly negligible at this temperature; a much higher temperature may be permissible.
‖ Assumed surface temperature, 400° C.

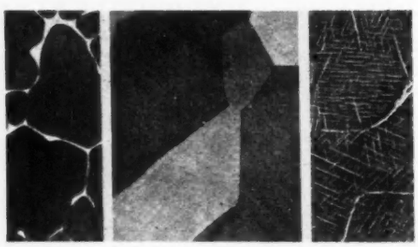


Fig. 3 Uranium carbide microstructures, with carbon contents (by weight), from left to right; (a) 4·5, (b) 4·8, and (c) 5·1 per cent.

Notes and News

European Power Demonstration Programme

An immediate start must be made in building a limited number of nuclear power plants of various kinds on a fully industrial scale in order to acquaint the operators as well as the constructors with the novel techniques. These words were not spoken by some American Atomic Energy Commissioner four years ago, but by M. Etienne Hirsch, president of Euratom, addressing the European Parliament in May this year. Euratom is determined to have the knowledge and facilities available for the large scale construction of nuclear power stations: by 1980 40,000 MW(e) installed nuclear generating capacity will be needed at the most conservative estimates. It is interesting to note that M. Hirsch spoke four months *after* the virtual collapse of the US-Euratom project for building a series of power stations of American design ("German Programme Reduced to Nil," Atomic Review, 29 Jan.'60).

Euratom to Participate in Marine Projects

In order to avoid duplication in marine reactor development, undertaken by most maritime nations, it is felt that Euratom could act as a coordinating body. Below is Euratom's report on the present status of reactor projects in various countries, and the extent to which Euratom is likely to participate. In addition to coordination, Euratom's participation in a project would make the resources of important research facilities such as Ispra and Petten available to private companies, in addition to any financial assistance.

Belgium: With the aid of the Centre d'Etudes Nucléaires at Mol, Belgian industry intends to develop a pressurised-water reactor in which the moderator contains a variable quantity of heavy water.

Germany: Under the aegis of the Federal Ministry and in collaboration with the German shipyards, five German firms are in intense competition not similar to those in the United Kingdom. Siemens, collaborating with Westinghouse, propose a 70 MW (t) pressurised-water reactor, while the AEG group plans a boiling-water reactor based on General Electric experience. A third project, originating from Deutsche Babcock and Wilcox, uses an advanced gas-cooled reactor; the Brown Boveri—Krupp group their high-temperature gas-cooled reactor. The Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt (GKSS) placed an order 18 months ago with INTERATOM (a subsidiary of Atomics International and Demag) for an OMR marine reactor study. As the result of an interview on 30 May between the Federal German Minister for Nuclear Power, Professor Balke, and the European Commissioner, Mr. de Groote, it was agreed that Euratom might take part in the latter project, and on 24 June, 1960, a meeting was held in Hamburg between experts from Euratom, the Federal Ministry and GKSS to plan a programme and to agree on the extent of Euratom participation. Euratom may also contribute to the simulated rolling and pitching tests, and the health protection research carried out by GKSS at Geesthacht.

France: Some time ago, the French Atomic Energy Commission (CEA) and the Secretary of State for the Merchant Navy proposed that Euratom participate in a research programme on the construction of an experimental gas-cooled marine reactor. The reactor would be built on shore and would have a power of 25 MW(t). Euratom is taking a close interest in this project and is conducting technical discussions with CEA experts to determine the level of Euratom participation.

Italy: Fiat, another Westinghouse associate, and the Ansaldo Shipyards of Genoa will soon submit to Euratom a project for a nuclear-powered tanker equipped with a 70 MW(t) pressurised-water reactor. The Comitato Nazionale per le Ricerche Nucleari has requested Euratom's participation.

Netherlands: The Dutch body responsible for nuclear power, the RCN, working in collaboration with a group of industrial concerns, is drawing up a 60 MW(t) pressurised-water marine reactor project.

Reports Received: Gas-Graphite Reaction

Experimental Techniques: Instruments, apparatus and techniques developed over seven years for the study of carbon dioxide with graphite reactions are described. The kinetic reaction may be followed by a gas circulation system. Sealed-tube experiments are used for the determination of geometrical effects. For mass-transfer measurements the most favourable arrangement is a gas circulation system from which the reaction products are continuously removed. (N. S. Corney, W. R. Marsh and J. Wright: "Experimental Techniques in the Study of the Reaction Between Carbon Dioxide and Graphite Under Irradiation," AERE—M667.)

Temperature Dependence: Below 600° C the formation of carbon monoxide from the carbon dioxide with graphite reaction is virtually independent of temperature, but above 650° C the thermal decomposition of surface oxide takes place and the mass-stransfer rate increases. (H. B. F. Gow and W. R. Marsh: "Temperature Effects on the Radiation Induced Reaction of Carbon Dioxide with Graphite," AERE—R3194.)

Instrumentation for Stability Experiment

Nearly thirty engineers will be engaged for 18 months on the design of control room equipment and instrumentation for the Atomic Energy Authority's Intermediate Current Stability Experiment (ICSE), successor to Zeta. The contract was awarded to the Solartron Electronic Group, who will be assisted in certain phases of the design work by Gresham-Lion Electronics.

Advanced SNAP by Martin Nuclear

Having demonstrated the feasibility of electrical generation from the decay heat of radioactive isotopes in two experimental models SNAP 1-A and SNAP-3, the Martin Company have now received a contract to extend the technique to a working model. The device, as yet unnamed, will be used to power an unmanned weather station that will record temperature, wind speed, wind direction and barometric pressure. A comparison of the various models is shown in the table below:

	SNAP 1-A	SNAP-3	Advanced Model
Power	125 W	3·5 W	5 W
Life	1 year	1 year	2 years minimum
Isotope	Cerium 144	Polonium 210	Strontium 90
Weight	175 lb	4 lb	1,680 lb with shield

So far eight generators have been built in the SNAP-3 programme, three of which operated on isotope fuel, the others were electrically heated. The first fuelled unit of the SNAP 1-A design will begin tests early in 1961, while the weather telemetry station is scheduled for operation at the end of 1961.

Reactor Notes

Reactor for Brunel College: It is suggested that Brunel College, Acton, will acquire a research and training reactor during the 1964-68 building programme.

After Oldbury, Wylfa Head: The latest CEGB selection for a nuclear plant site is at Wylfa Head, Anglesey. If approved, construction is unlikely to start before 1963.

B and W Test Facility Plan Abandoned: Negotiations between the Babcock and Wilcox Company, New York, and the USAEC for the leasing of test space in a reactor that would have been owned and operate by Babcock and Wilcox have been discontinued. Apparently there is no longer a shortage of reactor test-space in the United States. (Atomic Review, 29 Jan. '60.)

Recent Criticalities: Venezuela and Israel have recently brought their first reactors to criticality. Israel has a 1 MW reactor of AMF design, Venezuela's is a 3 MW General Electric-General Nuclear Engineering reactor; both are of the pool type.

The

'Engineering' Appointments

Section

RESEARCH and **DEVELOPMENT DEPARTMENT**

Research Laboratories, Leatherhead, Surrey

HEAT TRANSFER SECTION

CHEMICAL ENGINEERS
MECHANICAL ENGINEERS
and PHYSICISTS are required with a sound knowledge of mass and heat-transfer. The work will consist of making a scientific analysis of the performance of large plants, with the object of improving efficiency and developing accurate design methods. There is ample scope for both fundamental and applied research and good experimental facilities are available.

Applicants should have an honours degree and, for the higher grades, considerable research experience in this field. Applications from newly qualified graduates will also be welcome.

Salaries according to duties and responsibilities will be on scales within the range £570-£1870 p.a.

There are good opportunities for promotion to higher grades. Where necessary, consideration may be given for financial assistance towards house purchase.

Applications stating age, qualifications, experience, present position and salary, to the Personnel Officer, 24/30, Holborn London, E.C.1, by 23rd August. Envelopes should be marked "Confidential Ref. ENG/288."

Central Electricity Generating Board

C 712

PUBLIC APPOINTMENTS

AIR MINISTRY

AIR MINISTRY Works Designs Branch requires in LONDON CIVIL ENGINEERING DESIGNER DRAUGHTSMEN with adequate training and drawing office experience in one or more of the following:—

(*a*) Roads, pavements, earthworks and storm-water drainage.
(*b*) Foul drainage and sewage disposal.
(*c*) Water supply and distribution.

Some site experience and possession of recognised technical qualification an advantage. Financial assistance and time off may be allowed for recognised courses of study. Promotion and pension prospects. Five-day week with 18 days paid leave per year initially. Salary ranges from £680 (at age 25) to £900 per annum. Commencing salary dependent on age, qualifications and experience. Applicants, who must be natural born British subjects, should write to AIR MINISTRY, W.G.d. LACON HOUSE, THEOBALDS ROAD, LONDON, W.C.1, or apply to any Employment Exchange quoting King's Cross 3746 giving age, details of training, qualifications, full particulars of former posts held and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. G 889

AUSTRALIA

ENGINEERS, METROPOLITAN WATER, SEWERAGE AND DRAINAGE BOARD OF NEW SOUTH WALES

Applications are invited from graduates or diplomates (preferably under 30 years of age) in Engineering for appointment to the Engineering Staff of the Metropolitan Water, Sewerage and Drainage Board of New South Wales. Because of accommodation difficulties, vacancies exist only for single men and married men without children.

Minimum commencing salary, £A1242 p.a. for a diplomate and £A1360 p.a. for a graduate, with incremental progression, subject to satisfactory service, to £A2002 p.a. Progression beyond this rate is by appointment as vacancies arise.

The main requirement is for Civil Engineers, who have just completed training but consideration will also be given to those with some experience and to graduates and diplomates in Mechanical, Electrical and Chemical Engineering.

Superannuation Scheme. Good leave conditions.

Successful applicants will be nominated for travel under the Assisted Passage Scheme. The cost of the passage is £10 per adult.

For further particulars and application forms please write to AGENT GENERAL FOR NEW SOUTH WALES, 56 STRAND, LONDON, W.C.2. C 717

AUSTRALIA

ENGINEERS/ARCHITECTS

NEW SOUTH WALES

PUBLIC SERVICE

QUALIFICATIONS:

Appropriate Degree, Diploma or Institute membership (by examination).

SALARY:

From £A1359 to £A2069. Commencing rate according to qualifications and experience. Promotion positions carry salaries up to £A2800 and beyond.

EXPERIENCE:

Civil, Mechanical and Electrical engineering or architectural design and supervision. Applicants will be employed in the New South Wales Department of Public Works on a wide range of engineering and architectural projects including dam, water supply, sewerage, road and bridge construction, building services, and in the construction of schools, hospitals and other public buildings.

Subject to satisfactory medical report the successful applicant and family under the age of 19 years will be nominated to travel under the Assisted Passage Scheme to New South Wales.

Further details and copies of application forms obtainable from AGENT GENERAL FOR NEW SOUTH WALES, 56-57 STRAND, LONDON, W.C.2. Applications close on 31st AUGUST, 1960. C 718

CHEMISTS, MATHEMATICIANS (including **STATISTICIANS), METALLURGISTS, MECHANICAL** and **ELECTRICAL ENGINEERS, AND PHYSICISTS** (including **BIO-PHYSICISTS)** (men and women).

Required for RESEARCH and DEVELOPMENT ESTABLISHMENTS of WAR OFFICE at various locations including Sevenoaks, Kent; Byfleet, Chertsey and Tolworth, Surrey; Shoeburyness, Essex; Christchurch and Farnborough, Hants.; Salisbury, Wilts.; Cornwall. Appointments in grades of (*a*) SENIOR SCIENTIFIC OFFICER, £1250-£1540 or (*b*) S.O., £690-£1145. Starting salary according to experience. (Women's rates the same by 1961.) Superannuation under F.S.S.U., with opportunities for candidates under 31 to compete for established (pensionable) posts. 1st or 2nd Class Hons. degree or equivalent required, and for (*a*) minimum age 27 and at least 3 years' post-graduate research experience. Forms from TECHNICAL AND SCIENTIFIC REGISTER (K), MINISTRY OF LABOUR, 26, KING STREET, LONDON, S.W.1, quoting A.300/OA. C 724

The following

PHYSICISTS

are required for a test team to operate the British Nuclear Prototype Propulsion Machinery, situated at Dounreay, Caithness, Scotland:

ONE HEALTH AND SAFETY PHYSICIST

ONE SENIOR HEALTH PHYSICIST

ONE JUNIOR HEALTH PHYSICIST

The first two are senior appointments and applicants should have had previous experience in the field of Health Physics. In the case of the Health and Safety Physicist, practical experience in the operation of reactors is a requirement.

The Company operates a contributory pension fund and applications giving full details should be sent to:

The Manager, Marine Propulsion,
Research and Development Dept.,

VICKERS-ARMSTRONGS (ENGINEERS) LIMITED,

Naval Construction Works, Barrow-in-Furness, Lancs.

C 729

THE ROYAL COLLEGE OF SCIENCE AND TECHNOLOGY, GLASGOW

(In affiliation with the University of Glasgow)

DEPARTMENT OF MECHANICAL, CIVIL AND CHEMICAL ENGINEERING

Applications are invited for the following posts:—

(*a*) SENIOR LECTURER—Servomechanisms and Control Engineering.
(*b*) SENIOR LECTURER—Structural Engineering
(*c*) SENIOR LECTURER—Engineering Drawing.
(*d*) LECTURER—Strength of Materials and Elasticity.
(*e*) LECTURER AND ASSISTANT LECTURER—Applied Mechanics
(*f*) LECTURER—Engineering Drawing.
(*g*) LECTURER—Thermodynamics
(*h*) LECTURER—Production Engineering
(*i*) LECTURER—Chemical Engineering

In general, applicants should have an Honours Degree and professional qualifications, with teaching and/or research experience.

Excellent research facilities available.

Salary scales—Senior Lecturer, £1900 by £75 to £2275.
Lecturer, £1050 by £50 to £1400 by £75 to £1850.
Assistant Lecturer, £800 by £50 to £950.

Family Allowances and F.S.S.U.

Full details of each post and forms of application may be obtained from the SECRETARY OF THE COLLEGE, GEORGE STREET, C.1.

C 704

APPLEBY-FRODINGHAM STEEL COMPANY

SCUNTHORPE, LINCOLNSHIRE

invite applications for

SENIOR DESIGNERS

also

SENIOR & JUNIOR DRAUGHTSMEN

for general engineering work

Experience with plant for Iron and Steelworks would be an advantage but is not essential.

Permanent situations with good prospects of advancement for men with initiative and ability.

Staff Pension Scheme, welfare and sports facilities are available.

Apply, giving age, full particulars of previous experience and technical qualifications to the CHIEF ENGINEER. C 633

SURREY EDUCATION COMMITTEE

KINGSTON TECHNICAL COLLEGE

FASSETT ROAD, KINGSTON-UPON-THAMES

Required 1st September, or as soon as possible thereafter.

DEPARTMENT OF ELECTRICAL ENGINEERING

Lecturer in Electrical Engineering. Candidates should possess a degree in Electrical Engineering and appropriate professional qualifications, with teaching and industrial or research experience. Salary: Burnham Technical Scale.

Further particulars from Principal on receipt of stamped addressed envelope. C 715

CLYDE NAVIGATION TRUST

HYDROGRAPHIC SURVEYOR

Applications are invited, from suitably qualified candidates, for the post of Hydrographic Surveyor on the staff of the Trust.

Applicants must have experience in taking soundings by lead line and by echo sounding machine. Good draughtsmanship is essential and applicants should have the ability to plot soundings and to prepare dredging plans and estimates.

Applicants should state age, and full particulars of education, training and experience.

The commencing salary will be £995, rising to £1240 per annum. The successful applicant will be required to pass a medical examination and become a member of the Trustees' Superannuation Fund.

Applications, which will be treated in strictest confidence, should be lodged with the ENGINEER, CLYDE NAVIGATION TRUST, 16 ROBERTSON STREET, GLASGOW, C.2.

C 699

ROYAL TECHNICAL COLLEGE

SALFORD

DEPARTMENT OF MECHANICAL ENGINEERING

Applications are invited for appointments in this COLLEGE OF ADVANCED TECHNOLOGY as—LECTURERS IN MECHANICAL ENGINEERING

Applicants should have an honours degree, or equivalent, in engineering or applied science, and industrial, research or teaching experience. The persons appointed will be expected to carry out research in mechanical engineering for which excellent facilities exist. Subject to reasonable safeguards, staff are encouraged to engage in consulting work for industry. There are good prospects of further advancement.

These posts offer excellent opportunities to take part in the development of technological education in the present important phase of its growth.

The salary scale is £1370 p.a., rising to £1550 p.a. Appointments may be made at appropriate points.

Further particulars and forms of application may be obtained from the REGISTRAR, ROYAL TECHNICAL COLLEGE, SALFORD, LANCS., to whom completed forms must be returned by 31st AUGUST, 1960. C 719

THE UNIVERSITY OF SHEFFIELD

Applications are invited for two RESEARCH BURSARIES in The DEPARTMENT OF FUEL TECHNOLOGY AND CHEMICAL ENGINEERING. The successful applicants will be required to join a team working on the formation and evolution of coal smoke. Applicants should have a good honours degree or M.Sc. in Chemistry, Physics, or Engineering, and would be expected to register for the Ph.D. degree. Salary on the D.S.I.R. Studentship scale.—Applications should reach the REGISTRAR, THE UNIVERSITY, SHEFFIELD 10, by 30th SEPTEMBER, 1960. C 716

HUDDERSFIELD COLLEGE OF TECHNOLOGY

PRINCIPAL: DR. W. E. SCOTT, M.B.E.

DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING

Required as soon as possible, LECTURER to teach Production Engineering subjects mainly in courses up to Higher National Diploma (Production), including Principles of Engineering Production, and to carry out research relating to Production Engineering.

Salary: Burnham Scale £1370 p.a. by £35 p.a. to £1550 p.a. The commencing salary will depend upon qualifications and experience.

Forms of application and further particulars obtainable from the PRINCIPAL, to whom applications should be returned without delay.

H. GRAY,
CLERK TO THE GOVERNORS.

C 739

QUEEN MARY COLLEGE

(UNIVERSITY OF LONDON)

Applications are invited for the post of LECTURER IN THE DEPARTMENT OF CIVIL ENGINEERING. Applicants should have had at least two years of Civil Engineering practice. Experience in teaching and research will be an advantage. Tenable 1st October 1960. Salary scale: £1050 by £50 to £1400 by £75 to £1550 (efficiency bar); by £75 to £1850, plus London Allowance £60. F.S.S.U. participation and family allowance of £50 for each child. —Application forms, obtainable from the REGISTRAR, QUEEN MARY COLLEGE, MILE END ROAD, E.1, to be returned by AUGUST 22nd. C 736

NATIONAL COAL BOARD

NORTH EASTERN DIVISION

DEMONSTRATORS required in Technical Sales Service of Yorkshire Sales Region, to advise and help boiler house staff, chiefly at industrial premises, in correct operation of solid fuel burning plant. Wide practical experience in operation of mechanically fired boilers and/or furnaces using solid fuel necessary, and experience of hand fired plant desirable. Sound knowledge of instruments to control performance essential.

Three posts, based on Sheffield or Leeds. Salary within range £750-£1150.—Apply to STAFF DEPARTMENT, 16 SOUTH PARADE, DONCASTER, by 24th AUGUST (Quote AA/553). C 734

RESEARCH FELLOWSHIPS

(3 YEARS) IN

GOVERNMENT SCIENTIFIC ESTABLISHMENTS

Value £1150-£1400 p.a. (Senior) and £800-£1100 p.a. (Junior). A very wide range of topics, especially in the PHYSICAL SCIENCES; also several vacancies in various branches of BIOLOGY. Qualifications: normally first or second class honours degree; evidence of high standard of ability in research; and at least 2 years' post-graduate research experience (3 years for Senior Fellowships). No age limits. F.S.S.U.—Write CIVIL SERVICE COMMISSION, 17 NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting S.5060/60. C 725

DEPARTMENT OF ELECTRICAL ENGINEERING

KUMASI COLLEGE OF TECHNOLOGY, GHANA

Applications are invited for two posts of TECHNICAL INSTRUCTORS in the Department of Electrical Engineering.

Applicants must have had a sound technical education and should possess either the Higher National Certificate or Diploma. Some experience in Technical College work will be an advantage.

Successful candidates will take full-time classes in a 4-year diploma course in Electrical Engineering, prepare and supervise laboratory work in Electrical Power, Machines and Measurements and assist in laboratory development and research work.

The Contract Salary Scale is £1295 by £56 to £1855.

In addition children's allowances are paid up to a maximum of three, and a gratuity at the end of the contract at the rate of £150 for each year of satisfactory service. The entry point is fixed according to qualifications and experience.

The College is fully residential, and members of staff are housed in pleasant modern bungalows on the spacious campus: climate and living conditions are good.

Annual leave with three free return passages in four years is granted to members of staff and their families.

Application forms and an Information Brochure may be obtained from the ASSISTANT REGISTRAR, KUMASI COLLEGE OF TECHNOLOGY, 29 TAVISTOCK SQUARE, LONDON, W.C.1, who will also be glad to answer any questions about this appointment. The Closing Date for applications is mid-August.

C 726

WOLVERHAMPTON CORPORATION

WATER UNDERTAKING

requires two ENGINEERING ASSISTANTS for new works design and construction. Salary according to qualifications and experience, £1065-£1220 (Grade APT IV) or £785-£1070 (Special Grade), N.J.C. Service Conditions, 5 day week, house to rent. Post pensionable, medical examination.—Applications, naming two referees, to WATER ENGINEER AND MANAGER, WATER OFFICES, 37 MERRIDALE ROAD, WOLVERHAMPTON, by AUGUST 29th, 1960. C 738

APPOINTMENTS OPEN

MECHANICAL ENGINEERING ASSISTANT

MECHANICAL ENGINEERING ASSISTANT REQUIRED for design and development work on cable-making machinery. Some electrical experience is desirable. Applicant should have had practical experience as well as theoretical training at least up to H.N.C. standard. He must be capable of following his designs through manufacture and subsequent application. The work is interesting and offers scope to an inventive mind. Age 25-35. Salary commensurate with ability and qualifications. —Apply in confidence to Personnel Officer, Southern United Telephone Cables Ltd., Dagenham, Essex. C 730

THE REED PAPER GROUP

requires an

INSTRUMENT PROJECT ENGINEER

Applicants, aged under 45 years, should have H.N.C. as a minimum qualification and previous experience in a responsible position connected with Process Instrumentation is essential.

Applicants should be capable of selecting suitable equipment and of organising and approving installations.

Commencing salary will be by arrangement with the successful applicant.

Conditions of service include non-contributory superannuation scheme and assistance with house purchase, if required.

Written applications, with full details of career to date should be addressed to:—THE GROUP PERSONNEL OFFICER, ALBERT E. REED & CO. LTD., LARKFIELD, NR. MAIDSTONE, KENT, quoting reference IPE/GE/67.

C 733

LAPORTE CHEMICALS LIMITED WARRINGTON

require an INSTRUMENT ENGINEER to take complete responsibility for their progressive Instrument Department. Age between 26-45 years. Minimum qualifications—H.N.C. Applicants should have a thorough knowledge of modern pneumatic and electronic instruments and experience in the maintenance of automatic control equipment in heavy chemical or petroleum processes. A good salary will be paid commensurate with age and experience. A Pension Scheme is in operation, and, in selected cases, assistance can be given towards removal expenses and house purchase.

Replies, giving details of age, qualifications and experience, and quoting Ref. LCW/E1/58, should be addressed to the GROUP PERSONNEL MANAGER, LAPORTE INDUSTRIES LIMITED, HANOVER HOUSE, 14 HANOVER SQUARE, LONDON, W.1.

C 731

DESIGNER DRAUGHTSMAN

DESIGNER/DRAUGHTSMAN required for small but expanding Company in SOUTH BUCKS to extend their range of Centrifugal Pumps and other projects. Candidates must have experience of pump applications including hot water circulation duties and be able to work without supervision.—Apply stating age, experience and salary required, to: BOX C 728, Offices of ENGINEERING.

ELECTRICAL DESIGN ENGINEERS

PILKINGTON BROTHERS LIMITED, COWLEY HILL WORKS, invite applications from Electrical Design Engineers to take charge of a small Electrical Drawing Office, and be responsible to the Works Electrical Engineer for H.V. and M.V. Distribution Schemes, including lighting circuits and a certain amount of D.C. work, in all amounting to a maximum demand of 15 M.V.A. He will also be responsible for estimates and ordering of materials. Five-day week, superannuation scheme, assistance with house purchase. Applicants, who should have H.N.C. and, preferably, Graduate Membership of the I.E.E., should write to the WORKS PERSONNEL OFFICER, COWLEY HILL WORKS, PILKINGTON BROTHERS LIMITED, ST. HELENS, giving details of age and experience. C 714

ENGINEER SURVEYOR

ENGINEER SURVEYOR required for inspection of Boiler and Pressure plant. Must have 1st Class M.O.T. Certificate with Steam endorsement or equivalent. Starting salary £800, rises to £1100 (E.S.A. Scale). Other benefits. Area Chester and North Wales.—Apply ENG. DEPT., GENERAL ASSURANCE CORP. LTD., 99, ALDWYCH, W.C.2. C 720

EXPERIENCED ENGINEER AND BOILER SHOP PRODUCTION MANAGER

A leading engineering works near Calcutta requires an EXPERIENCED ENGINEER to control production of Boiler manufacture, Pressure vessels, Wagons, Cranes, Steel structural work and General heavy engineering. He will be responsible to the General Manager for all activities including product design and drawings, manufacturing methods, production programmes, costing, etc. Candidates should preferably be about 50 years of age but age is not an overriding consideration. This is a top ranking employment, salary equivalent to £4,500 p.a., free accommodation and car provided.

Also a BOILER SHOP PRODUCTION MANAGER required for same Company capable of controlling a large Boiler Shop manufacturing Water Tube Boilers. A really practical man about 35 to 40 years of age required. Excellent conditions offered to suitable applicants.—Apply with full particulars of education, career, to BOX C 723, Offices of ENGINEERING.

ENGINEER

ENGINEER for Inspection of Cranes and Lifting Plant required. Must have drawing office experience of design of Cranes, also National Certificate in Mechanical Engineering. Areas Essex and Liverpool. Starting salary, £800 rising to £1100—other benefits—permanent—Write BOX EG720, LPE, ROMANO HOUSE, 399/401 STRAND, LONDON, W.C.2. C 721

PLANNING AND PROGRESS ENGINEER

required by the UNITED KINGDOM ATOMIC ENERGY AUTHORITY, PRODUCTION GROUP, SPRINGFIELDS WORKS, SALWICK, PRESTON, LANCASHIRE, to be responsible to the Senior Planning Engineer for planning and progressing of engineering projects carried out by the Works Engineering Department; co-ordination of work of sections of the Engineering Department, including Design; and operation of a comprehensive planned maintenance scheme.

A recognised engineering apprenticeship, corporate membership of a senior engineering institution, or equivalent, and extensive experience in planning and progress as applied to a large Works Engineering Department, are essential. Experience in initiation and operation of planned preventative maintenance schemes is desirable.

Salary: £1370 to £1825 per annum.

Staff Housing Scheme. Contributory Superannuation.

Send postcard for application form, quoting reference SF.50/JZ, to Works Secretary at above address.

Closing date: 22nd AUGUST, 1960. C 698

LIFT ENGINEER

LIFT ENGINEER required by Insurance Company for inspection of lifts. Must have served apprenticeship with lift construction firm and hold at least O.N.C. or equivalent in Electrical or Mechanical engineering. London. Starting salary, £800 p.a., pension, widows' pension, etc.—Write with full details to BOX EG 728, LPE, ROMANO HOUSE, 399/401 STRAND, LONDON, W.C.2. C 740

MANAGER

required to

TAKE CHARGE OF ERECTION SHOP

for construction of heat exchangers, pressure vessels and fabricated structures. He should have experience of welding and general fabrication and be fully conversant with manufacturing techniques to satisfy Lloyds Class 2, A.S.M.E., etc., codes. New buildings and equipment are projected for this expanding side of the firm's business and the situation requires a man fully capable of developing manufacture to high standards. Age 35/40. Salary in the range of £1500 to £2000. Non-contributory pension scheme. Location—Gloucester area.—BOX C 735, Offices of ENGINEERING.

PA PERSONNEL ADMINISTRATION LIMITED

MANAGEMENT CONSULTANTS

Our Appointments Division has been asked to advise on the following post:

PRODUCTION ENGINEER

LONDON

A large British organisation providing a vital service to a major industry has decided to create a Production Engineering Division. The Divisional Manager will be required to devise and implement his own programme of projects covering process layout, methods, machinery, material flow and work measurement (not incentives). This will involve building a team of specialists who will operate in all parts of the country. Candidates should be graduates or professional engineers between 35 and 45 with wide production engineering experience preferably in large scale industries such as automobiles, aircraft or shipbuilding. Management Consultants are particularly welcome. Salary up to £3000; pension. Although this is a permanent post the experience would probably lead to one of the top posts in the industry. (Ref. 1451/EN.)

The identity of candidates will not be revealed to our clients without their prior permission. For the convenience of clients and candidates we have Regional Offices in ***Glasgow, Manchester, Bristol*** *and* ***Birmingham*** *but in the first instance, applicants should forward brief details, quoting the reference number, to:—*

PERSONNEL ADMINISTRATION LIMITED

APPOINTMENTS DIVISION, 2 ALBERT GATE, LONDON, S.W.1 C 701

ICI IMPERIAL ALUMINIUM COMPANY LIMITED

require

TWO SENIOR DEVELOPMENT ENGINEERS

experienced in technical sales development, to be responsible for the development of new aluminium products, and their sales, in the Building and Electrical industries, respectively. Applicants should preferably be graduate engineers with several years experience of design, development, or sales activities in the appropriate industry.

Commencing salary will be dependent on age and experience. Assistance can be given to married men towards house purchase and removal expenses.

Please write for an application form to the PERSONNEL MANAGER, IMPERIAL ALUMINIUM COMPANY LIMITED, KYNOCH WORKS, WILTON, BIRMINGHAM 6,

quoting DEV/442/ENG. C 707

As a result of expanding production operations another

MAINTENANCE ENGINEER

FOR MARINE OPERATIONS

is required by TEXACO TRINIDAD, INC.,

for service in TRINIDAD

Applicants should be between thirty and thirty-nine years of age and be Graduate Engineers or Associate Members of the Institution of Civil Engineers or Institution of Mechanical Engineers.

They should have served an apprenticeship with a firm of General Construction or Structural Engineers, or with one dealing with heavy industrial handling equipment. A further requirement is 8 years industrial experience and a good knowledge of welding practices and cathodic protection methods. The ability to drive a motor vehicle is essential. Duties will include supervision of the erection of marine structures for production operations, the maintenance of marine plant, and laying submarine pipelines.

The starting salary will be subject to age and experience but will not exceed £1700 per annum. The Company provides accommodation at low rental, and there are excellent facilities for sport and a generous pension scheme, while Home Leave is granted at the end of 3 years' service.

If you have the qualifications and experience which fit you for this appointment, please write for an application form and staff brochure to:—

The Personnel Officer, Trinoil (U.K.) Limited,

29/30 Old Burlington Street, London, W.1

C 708

QUALITY MANAGER

Applications are invited immediately from experienced QUALITY ENGINEERS for the post of QUALITY MANAGER in a mass-production light engineering firm in the Glasgow area.

The Quality Manager will be responsible for the maintenance of quality throughout the works, and for the quality of large quantities of bought-out parts.

Suitable qualifications would include all or most of the following: (i) An engineering apprenticeship followed by at least five years' experience in a light engineering industry; (ii) Five to ten years' experience as a quality engineer or Manager in a large organisation, with experience in handling staff; (iii) An engineering degree or equivalent; (iv) Associate membership of the Institution of Mechanical and/or Production Engineers.

Experience and personality, plus the ability to make correct decisions and to implement same quickly, are essential requirements.

This is a Senior Staff appointment, and will carry a good four-figure salary, depending upon the calibre of the person appointed. Applications which will be treated in strict confidence, should give details of age, experience in chronological order, and present position and salary.

BOX C 658, Offices of ENGINEERING.

WORK STUDY ENGINEERS

WORK STUDY ENGINEERS are invited to apply for vacancies that offer temporary engagements, at advantageous terms of 1 to 2 years' duration, in a light Engineering factory situated in the Midlands.

The project involved is of importance and concerns review, re-study and implementation of Company Policy in the application of Work Study affecting several thousand employees.

Permanent posts will be available to some participants on completion of this project.

Applicants should write, quoting E/M, stating age, qualifications and experience, to THE PERSONNEL MANAGER, BOX C 700, Offices of ENGINEERING.

QUALIFIED PRODUCTION MANAGER

for Bearing Factory in INDIA

aged 40-45. Applicants should have had long experience in light engineering industry and of modern production methods and preferably some experience in the bearing industry. Commencing engagement is for minimum of three years in India. Some training if necessary will be given for an initial period in the United Kingdom. Very attractive terms for suitable candidate.—Write giving details of education, training, qualifications and experience, to BOX E.485, c/o STREETS, 110, Old Broad Street, E.C.2. C 709

ASSISTANT DESIGNER

Applications are invited for a post as ASSISTANT DESIGNER for work on Steam Turbines, Centrifugal Blowers and Compressors and allied equipment. Applicants should be about 25 years of age and possess University Degree, H.N.C. or equivalent in Mechanical Engineering, and should preferably have had some practical experience. Salary according to qualifications and experience.—Write, giving particulars, to D. ADAMSON & CO., ENGINEERS, DUKINFIELD, CHESHIRE. C 677

TECHNICAL AUTHOR

TECHNICAL AUTHOR required, not over 45, to assume responsibility for the compilation of operating and maintenance instruction manuals dealing with the Company's machinery. This interesting and progressive pensionable staff position would appeal to a suitably qualified Mechanical Engineer with a bias towards technical writing.—Applications should be addressed to the PERSONNEL MANAGER, MOLINS MACHINE CO., LTD., EVELYN STREET, LONDON, S.E.8. C 693

APPOINTMENT WANTED

AGE 36. B.SC.TECH., G.I.MECH.E./AUT.E. 3 years Royal Navy (El. 5 years development work. 9 years oil company. Presently Transport Manager abroad. Seeks position of responsibility requiring drive, high organising ability and enthusiasm, but with high potential advancement. Prepared to apply within wide limits executive and engineering "know how" and experience to any aspect of industry in U.K.—Apply BOX C 737, Offices of ENGINEERING.

G.W.B. FURNACES LIMITED

CONTROL GEAR DIVISION

SALES ENGINEER

required for London and the Home Counties.
He should have experience of electric motor control gear, contactors, relays, multi-motor control panels, switchboards, etc.
This is a senior appointment and a good salary is paid, plus expenses. The position is permanent and pensionable.
A company car is provided.
Write in confidence, giving details of age, qualifications and career to date, to:

SALES MANAGER,
CONTROL GEAR DIVISION,
G.W.B. Furnaces Limited,
DUDLEY,
WORCS.

C 702

PROJECT ENGINEER (INDIA)

PROJECT ENGINEER required by well known British Company of Engineering Contractors engaged on the building of heavy engineering plant. Applicants must have civil and/or mechanical engineering qualifications and experience of site construction is desirable. Preference will be given to applicants aged 25/40 who are qualified civil engineers with experience of plant erection. If required married accommodation will be available in Calcutta but the successful applicant must be prepared to travel to any contract in India. Good salary and bonus will be paid. Pension scheme is in operation. Tour of duty will be for three years initially with liberal leave. Send full details of training, qualifications and experience, in strictest confidence, to BOX C 703, Offices of ENGINEERING.

'Engineering' Appointments Section

ADVERTISEMENT RATES

CLASSIFICATIONS: Public Appointments, Appointments Open, Appointments Wanted.

TYPES OF ADVERTISEMENTS:

(a) "Appointments Illustrated" and illustrated careers advertisements: photographs or drawings may be used in conjunction with type matter.

Rates per page: (12 in. by 9 in.)	£100
half page	£54
quarter page	£29

(b) Semi-display: type matter, with or without surrounding rule, name block or symbol.

Rates: per page (12 in. by 9 in.)	£100
half page	£54
quarter page	£29
single column inch	£2 14s.

(c) Single column "run-on" advertisements: approximately 6 words to the line, 12 lines to the inch.

Rate per line (Minimum charge 18s.	4s. 6d.

SERIES DISCOUNTS: 5 per cent. on 6 insertions; 10 per cent. on 13 15 per cent. on 26.

BOX NUMBER: 2s.

Company Meetings

Quarter page, £29; half page, £54; full page, £100.

COPY DATE: First post Monday.

BLOCKS: To be mounted ready for printing. Screen 100.

ORDERS TO: "Engineering" 36, Bedford Street, London, W.C.2. (Telephone TEMple Bar 3663)

Companies

Tough Going for Electrical Manufacturer

SIR Leslie Gamage, the GENERAL ELECTRIC Company chairman, cautiously indicates in his annual statement that only by strenuous efforts in cutting spending and increasing sales will the company maintain the excellent results of the year which ended in March.

That the year under review was markedly successful is reflected in its turnover reaching a record £117 million, an increase of 8·2 per cent. The trading profit rose from £9,353,814 to £11,073,872. After allowing for heavily increasing depreciation, tax and £500,000 against the nuclear power station contract at Hunterston, the available profit figure is £2,322,135.

The tightened conditions of credit and the sharpening foreign competition combine to make the trading position at the moment more difficult than for some time but GEC is able to report orders received during the past year worth £119 million. The order book at the start of the current year was worth £138 million, an improvement of £5 million over the previous year. In both years the outstanding orders included £56 million for atomic energy contracts.

Sir Leslie reports a slight decline in the export position and the figures show that in total overseas sales there has been a small drop, from £23,771,000 to £23,618,000. GEC has still not been able to recover to the 1957 performance when its exports were worth £24,494,000.

Refrigerators Overseas

Part of the drop is explained in the extremely tough competition in the overseas refrigerator market. The company has made foreign sales, especially of the larger models, its primary target. There is now a first class battle going on to win back markets lost to the German and Italian manufacturers.

The three main prongs of the GEC struggle to improve performance are the sales effort, the research and development programme, and reorganisation in the company's groups.

Under the third heading, all the groups have been closely examined and a reorganisation programme is going on, particularly for the groups responsible for the sector known as General Products. The company's consultants, URWICK, ORR and Partners have assisted in advising and preparing the programme.

The former General Products group has been broken down into five autonomous groups, each with its own group managing director responsible to the chairman and the vice-chairman, Mr. A. L. G. Lindley. Each group will gradually become a complete integrated production and sales unit, functioning as if it were a separate company.

Among the fields in which the research staff are engaged is that of the properties of gaseous electrical discharge plasmas at microwave frequencies and their use for the control of extremely large currents. One of the basic physical mechanisms under investigation is that of commutation in electrical machines.

Right at the end of the tide of revival in industrial activity in 1959 came the benefits to the company's engineering group. This led to the group being able to bring in "a fair share" of the new orders about. These included contracts in traction, steelworks and mining equipment in addition to normal activity in electrical engineering. Profit margins in heavy engineering continued low.

Sir Leslie expects that the Government decision to further slow down the nuclear generating programme will definitely effect the continuance of a satisfactory level of work in the heavy engineering group.

Although salaries and wages went up by £740,000 during the year, as a percentage of sales they were brought down from 34·4 per cent to 32·4. This is still above the 31·0 per cent on 1956.

Metal-Working Lubricant Subsidiary

Metal-working lubricants, produced by an American concern who have been engaged in the business for almost a century, are to be marketed in the United Kingdom by a newly-formed company.

The new organisation is D. A. STUART OIL Company (GB), a wholly-owned subsidiary of the AMBER group of companies. They will sell the products of D. A. STUART OIL of Chicago and Toronto.

Cutting-oil concentrates, water-soluble and grinding fluids, metal forming oils and compounds are available through the subsidiary.

Firth Cleveland HP Business Recovering

Despite the first shock of the credit restrictions, the sales of the FIRTH CLEVELAND retail group are not unsatisfactory. This report came from Mr. C. W. Hayward, the Firth Cleveland chairman, at his annual meeting. He added that there are signs that the hire purchase activities were recovering from the early shock.

Order books in the group were generally in very good health and considerable increases in orders were reported for the first six months of the year by all the group companies.

The performance of companies making aircraft parts is known to be playing an increasing part in the export field. Mr. Hayward was able to announce that exports from SIMMONDS AEROCESSORIES had gone up by 40 per cent over the equivalent months of last year.

Ironfounders' Merger Proposals with Bilston

The ALLIED IRONFOUNDERS group have agreed merger terms with the directors of BILSTON FOUNDRIES. A joint announcement from the two companies states that the proposed terms are for the acquisition by Allied Ironfounders of the Bilston issued shares on the basis of two Allied Ironfounders £1 Ordinary shares for every fifteen Bilston 2s ordinary shares.

The offer is conditional on acceptance of holders of 90 per cent of the Bilston stock, or of any smaller amount that Allied Ironfounders were to agree to accept.

The two companies' statement reports that the trading results for Bilston in the year up to the end of this March were adversely affected by their running-in experience of a new foundry. The Bilston directors are not recommending a final dividend for the year.

Matterson Founder Given Honorary Degree

The founder of a Yorkshire engineering firm has been awarded the honorary degree of Master of Science by Leeds University.

The gear expert so honoured is Mr. William C. M. Matterson (inset),

founder and joint managing director of MATTERSON Limited, hoist and crane makers, of Rochdale, Yorkshire.

Mr. Matterson's engineering career led through David Brown and Sons, John Holroyd, and the Austin Motor Company, until he founded his firm in Rochdale.

He patented and developed a machine for generating bevel gears and an attachment for standard shaping machines, based on this patent, is still in use after 40 years.

Mr. Matterson, who is 75 years old, was put forward for conferment of the honorary degree by Professor D. C. Johnson, professor of mechanical engineering at Leeds.

United Steel's New Headquarters

The head office of the UNITED STEEL Companies Limited, previously situated in a number of converted houses in Sheffield, has now been established at "The Mount" there, a 126-year-old period building that has undergone extensive internal reconstruction, but in which the elegant pillared facade has been retained.

In general, it has been the intention of the architects to preserve the original character of the old building.

Behind The Mount, there has been built an entirely new four-storey block with an inter-connecting wing between the two.

In addition to private offices, including that of the chairman, Sir Walter Benton Jones, The Mount contains the board room, three well-appointed dining rooms and a fully equipped kitchen. In the basement, and below the garden in front of the building, a garage has been provided for the staffs' cars. The garage is fitted with washing and servicing bays.

Special features of the new building are the spacious printing department, in which much of the general printing for the company and its subsidiaries can be done, and a mechanised accounts department. This department possesses an ICT 1202 electronic computer which, in addition to accounts and general statistics, can also be used by the research and design sections within the group. The office also acts as a clearing house between the principal branches using a teleprinter link to each branch.

Architecturally, the building is important for it is believed to be the first to have window frames completely fabricated in stainless steel so that it will be free from any future maintenance costs.

Denny and Hawkers to Build Hovercraft

The Hovercraft industry grows apace. FOLLAND AIRCRAFT, Hamble, Hampshire, a subsidiary of HAWKER SIDDELEY, and the shipbuilding and marine engineering firm WILLIAM DENNY, of Dumbarton, Scotland, are to design and produce Hovercraft.

All four companies who have now announced plans in this field intend to cooperate with Hovercraft Development, the subsidiary of the NATIONAL RESEARCH DEVELOPMENT CORPORATION concerned with the exploitation of Hovercraft. The other two firms involved are the SAUNDERS-ROE division of WESTLAND AIRCRAFT (makers of the original SRN1) and VICKERS-ARMSTRONGS (AIRCRAFT).

William Denny, who are thus the first shipbuilders to take up Hovercraft, are to build the sidewalled craft for rivers and inland waters. The air cushion of such a vehicle will be contained by the vehicle's wells extended down into the water and by an air-wall at either end. Saunders-Roe are building at Cowes, on the Isle of Wight, the SRN2, which has four Blackburn A129 gas-turbine engines, with a total power of 3,000 h.p. This machine will be a 68 passenger 70 knot craft.

At their former Supermarine works near Swindon, Vickers-Armstrongs are to build two types of craft. One will weigh between 15 and 25 tons and will have a capacity suitable for ferrying cars and passengers. The other, described as a fast Hovercraft launch, will weigh between four and five tons.

The type of Hovercraft to be built by Folland is not yet known.

Working on their own, Britten-Norman, on the Isle of Wight, are working on Cushioncraft. ELDERS AND FYFFES, the banana people, are to carry out tests and may eventually be able to use the Cushioncraft to open up banana plantations in new areas unsuitable to road-using transport.

Cambridge Merger with Electronic Completed

The merger between the CAMBRIDGE INSTRUMENT Company and ELECTRONIC INSTRUMENTS Limited, of Richmond, Surrey, has been completed. Cambridge Instrument have now announced that their offer for the Electronic shares has been 100 per cent accepted.

Electronic Instruments are to continue trading under their own name and will retain the trade mark. Coordinated research, production and sales facilities should benefit both enterprises as the result of the move.

The Cambridge Instrument chairman, Dr. Percy Dunsheath, the company's managing director, and a third director have joined the Electronic board. Mr. Paul Goudime, managing director of Electronc has joined the Cambridge board.

Synthesising Neoprene

Neoprene is a general-purpose synthetic rubber made from hydrogen, chlorine and acetylene. Du Pont have opened a plant for its continuous production in Northern Ireland.

In the presence of a copper catalyst two molecules of acetylene gas react to form a third molecule of monovinylacetylene.

$$2(CH{\equiv}CH) \rightarrow CH_2{=}CH{-}C{\equiv}CH$$

Treatment of monovinylacetylene with hydrochloric acid gives a monomer or single-component substance known as chloroprene.

$$CH_2{=}CH{-}C{\equiv}CH + HCl \rightarrow CH_2{=}CH{-}\underset{\displaystyle Cl}{\underset{|}{C}}{=}CH_2$$

By polymerisation—the linking up of similar components or radicals in a series—chloroprene may be converted into polychloroprene, known generally as neoprene.

$$\cdots\cdots{-}CH_2{-}CH{=}\underset{\displaystyle Cl}{\underset{|}{C}}{-}CH_2{-}\cdots\cdots$$

Neoprene is a synthetic rubber superior in many respects to natural rubber.

The Maydown Works of Du Pont Company (United Kingdom) Limited employs these reactions to produce neoprene continuously on a large scale and has a design capacity of 50 million lb annually. It is a multiple-type plant built to prepare both dry neoprene and latices, an emulsified form. As may be gathered from Fig. 1, there are three major operating areas, MVA (monovinylacetylene), CD (chlorobutadiene) and polymerisation. These areas are serviced by separate nitrogen, hydrochloric acid and refrigeration facilities.

Acetylene gas is first reacted with itself, in the presence of a copper catalyst, to form monovinylacetylene. The reaction takes place in the MVA reactor shown in Fig. 2, followed by purification in distillation columns. Unreacted acetylene is recirculated. The MVA is transmitted to the CD area, where it reacts with hydrogen chloride to form chloroprene monomer, alternatively known as chlorobutadiene. Again there is recycling of the unconverted product. Pure chlorobutadiene then passes to the polymerisation area where the CD molecules are united under controlled conditions to form an elastomer, or elastic substance, which is next isolated as a film. The film is pulled into a "rope" and cut into chips which are talced and put into 50 lb bags.

The plant is operated from central control rooms, incorporating full indication and warning systems. Operators can make rapid adjustments in the continuous process to keep product quality up to standard.

Other manufacturing units supply materials and services to the areas already mentioned. The hydrochloric acid is produced by burning hydrogen with chlorine, the hydrogen being obtained by reforming propane. There is also a complete nitrogen production plant which prepares all the nitrogen required in the process. Nitrogen is used to prevent air contamination. A refrigeration area is responsible for producing the sub-zero temperatures required at certain stages of the cycle.

RAW MATERIALS AND WASTES

Most of the raw materials for the Maydown Works are produced in the United Kingdom. A chartered boat, the Marwit, is equipped to bring in 200 tons of chlorine plus packaged raw materials on each trip from Runcorn, in England, and to take back 500 tons of neoprene to Runcorn for distribution. Other raw materials are delivered by road transport. The plant has no rail service.

Acetylene.—Acetylene is supplied by pipeline from Carbide Industries Limited located to the north of the Maydown Works. This plant produces calcium carbide in an enclosed rotary electric furnace and reacts the carbide with water in a dry generator to supply acetylene.

Chlorine.—Chlorine is purchased from Imperial Chemical Industries Limited, at Runcorn, England, and transported by the Marwit to Maydown. It is unloaded by nitrogen pressure into a 700 ton storage bank.

Power.—The Electricity Board for Northern Ireland has built the Coolkeeragh power station adjacent to the Maydown site. The station supplies the Maydown Works with electricity, steam, cooling water and demineralised water.

Domestic Water.—The Londonderry Rural District Council built a new water treatment plant across the Faughan River to serve the three works at Maydown with domestic water.

Because of the spawning of salmon and sea trout in the Foyle River system it has been necessary to ensure that the aqueous wastes discharged to the Foyle are non-toxic to fish life. Extensive facilities to remove copper and neoprene wastes from the process streams have been provided and the total process waste stream is neutralised before flowing into the Foyle River. Two burners are provided for the organic wastes.

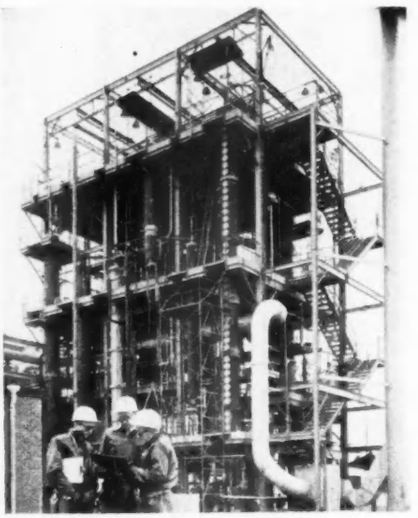


Fig. 2 The monovinylacetylene area, where the first step is taken in making neoprene.

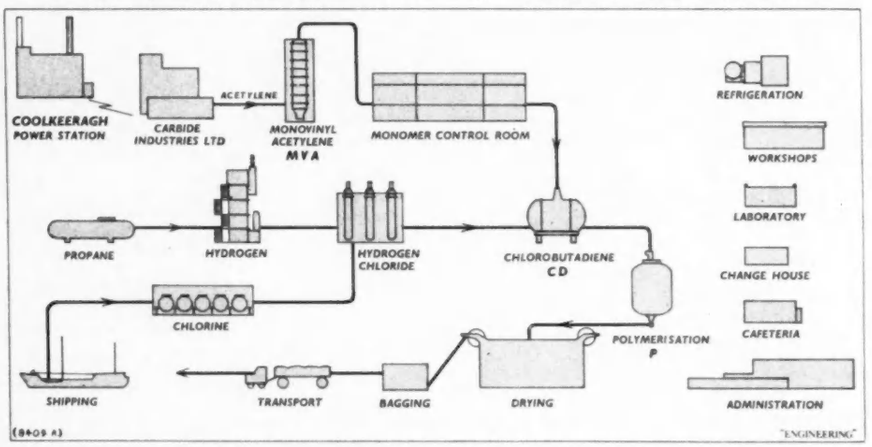


Fig. 1 Production of neoprene at Maydown Works is carried out in three principal stages.

UNNATURAL RUBBER

Neoprene offers many qualities not found in natural rubber or in many other synthetics. Its compounds resist deterioration from oils, greases, oxygen, ozone, and various chemicals. Neoprene products have excellent resistance to abrasion and wear, to cutting, chipping, and tearing; they stand up in sunlight and on exposure to the weather. Neoprene can be compounded to retain much of its flexibility at sub-zero temperatures. At the same time, its compounds are resistant to heat, and specially compounded products are flame-resistant; they do not support combustion. It can be formulated with the softness of a common rubber band or the hardness of a solid tyre.

For over 20 years, neoprene compounds have protected cables that are exposed to the baking rays of the sun or laid in salt marshes. They perform a great variety of jobs in the oil industry and are used for lining chemical tanks and pipelines.

Dissolved in a solvent, neoprene can be applied like paint: it has proved to be durable protective coating for equipment in chemical plants, plating shops, and other locations with corrosive, fume-laden atmospheres.

Neoprene is particularly well adapted for use in conveyor belts. It is being used successfully by architects for gaskets to seal glass and metal panels used extensively in skin wall construction. Several of the major tyre companies are now using neoprene in sidewalls to combat destructive ozone and oxidation found in the atmosphere—the major causes of tyre cracking.

In seeking a suitable location for the factory Du Pont explored many areas and found at Maydown, near Londonderry in Northern Ireland, a highly satisfactory combination of conditions—site, water, accessibility to power and material resources, proximity to the market, and a cooperative population with a good supply of competent and teachable labour. The works has provided over 400 jobs with recruiting as far as possible in the local area. The annual payroll is over £300,000.

The Maydown Works at present occupies 30 per cent of the 365 acre site. Construction started in January, 1958, and with a team of 18 American senior construction personnel and local labour was completed on schedule in 29 months. Some 95 per cent of the construction materials and equipment used in the plant, totalling about £4 million, was purchased in the United Kingdom.

The new plant was opened on 26 July by Lord Wakehurst, Governor of Northern Ireland, in the presence of Mr. Walter S. Carpenter, Jr., chairman of the Du Pont Company in the United States. Mr. William M. McCoy, managing director of the Du Pont Company (United Kingdom) Limited, announced plans for expanding the production capacity of the Maydown plant by 20 per cent.

Helicopter De-Icing is in the Balancing

Ice can be removed from helicopter blades by electrical heating mats. They must be hand built with extreme precision to maintain rotor balance. This calls for special production techniques.

When the weather tends to icing, wise helicopters tend to the ground. All-weather flying of helicopters has not yet been realised because ice-protection of the rotor blades is much more difficult than de-icing the vital surfaces on a fixed wing craft. Yet, oddly, the problems are the same, and the methods of solution which are now proposed are very similar; the difference is in production standards which are much more demanding when de-icing is applied to helicopter rotors.

Ice forms on aircraft surfaces under a wide range or air temperature, water content, and relative velocity. It destroys the aerodynamic properties of the surfaces and weighs down the craft. Two general methods have been evolved to combat ice formation: anti-icing, or the prevention of ice formation; and de-icing, or the periodic removal of accumulated ice.

Anti-icing on fixed wing craft can be done by heating the leading edges of wings and control surfaces electrically, by using the hot engine exhaust, or by spraying a fluid that will raise the melting point of ice on to the surfaces. De-icing can be done by pushing the ice off the wings by means of inflatable rubber "blisters" on the surface, or by heating the surface for short periods and shedding the accumulated ice. Fluid anti-icing is often used to protect the intake cowls of engines, while the wings, particularly of turbine driven aircraft, are usually protected by bleeding hot air from the engines.

Neither of these methods is very convenient when applied to the tail surfaces, and here the job is usually done electrically, using de-icing rather than anti-icing in order to save electricity. Napier have accumulated a great deal of experience in manufacturing the Spraymat electrical de-icing system.

The Spraymat equipment consists of a layer of insulating resin sprayed or brushed directly on to the surfaces, which then receive a layer of flame-sprayed metal divided into strips by masking, and connected to an electrical distribution system by a series of metal-foil busbars. An outer layer of insulating resin completes the installation which may receive an additional layer of paint, metal-resin compound or metal strip for protection.

Since a helicopter rotor is a precision component, the aerodynamic properties and weight distribution of the blades must be closely matched and must conform to rigorous standards. It is obvious that a Spraymat, which is essentially hand-produced from start to finish, could not meet such requirements unless very careful control of techniques are developed.

Rotor blade de-icing equipment must meet the following conditions. The rotor inertia must be left unaltered, or expressed in more convenient terms, the centre of gravity of each blade must be maintained within an ellipse with major and minor axes of 0·5 in and 0·05 in on a blade that is some 20 ft long and 1 ft wide. The total weight must be maintained within plus or minus 2 oz. The heater mats must be so constructed that the helicopter blades are fully interchangeable. It should be possible to apply the mats at the helicopter works rather than in Napier's workshops as the frequent transport of long blades is undesirable. And finally, the leading edge at the outboard end of the rotor must carry a metal strip for protection.

PILOT PRODUCTION

Napier have now installed a pilot scale production line for helicopter de-icing mats and are producing a trial series for the Westland Widgeon which will be flight tested in Canada. Others will be subjected to a programme of fatigue, erosion, thermal fatigue and heat transfer tests. Production of the prefabricated mats starts with a resin-glass cloth moulded to the shape of the blade in a jig. The heater element outlines are then carefully masked off and a base layer of Kumanal, a copper-manganese alloy, is flame-sprayed in a machine resembling a long planer. The resistance of each strip is then checked at 1½ in intervals and metal is added by hand-spraying, the aim being to correct any deficiency. Over-spraying can be corrected by scraping. The copper-foil end connections are then attached to the sprayed resistance strips and a second layer of resin-glass cloth bonded to the assembly as top insulation. Bonding is by means of a resin applied by brush, the excess resin and all entrained air which would blister when heat is applied being removed by careful hand pressing and stretching of the cloth.

To improve resistance to the impact of stones, a protective coating called Stoneguard is then applied. Stoneguard is a sticky paste consisting of 87 per cent powdered stainless steel and 13 per cent resin. Owing to the high metal content and tough resin, the paste can neither be brushed nor sprayed, and Stoneguard's future looked unpromising until the present method of application was evolved.

CONTROLLED THICKNESS

A bead of paste is extruded like toothpaste, along the leading edge of the mat. The mat is then vibrated horizontally along the longitudinal axis and warmed by hot air as shown in Fig. 1, causing the paste to flow. By this means an experienced operator can control the thickness to within 0·002 in, it is claimed.

The outboard end of the blade, travelling at near-sonic velocity, requires further protection and a 10 ft hard nickel strip is attached. In early tests on helicopters it was found that a shiny halo rotating over the pilot's head caused dizziness. The lower half of the nickel strip is blackened by electroplating to eliminate the phenomenon. Electroplating also has a function in the balancing process.

The production method of helicopter Spraymats is not very different from standard practice for fixed wing aircraft, the difference being in the balancing of the mat. Two special machines, shown in Fig. 2, have been built to check the weight distribution of the mats, these are believed to be more sensitive than the machines used for balancing the rotor blades themselves. The two machines are lined up side by side in a room with controlled atmospheric conditions. The flat truss in the foreground, is used for balancing along the blade chord. The Spraymat, visible on the ground in front of the machine, is placed on the sections of blade profile above the table and the moment is measured by means of weights and an optical indicator.

The triangular aluminium truss in the background is part of the equipment used for balancing along the length of the blade. The truss is supported on two sensitive weighing machines which are locked in turn to form a pivot, and the moment is measured at the opposite end.

To correct the balance of a mat, it is not possible to remove material except in very early stages of production. But since the total weight must be within plus or minus 2 oz of specification, the scope for adding material is equally limited. Hence, for the time being, a Spraymat is balanced chordwise and lengthwise after every production step, twelve times all told from start to finish.

It can be seen from Fig. 2 that the mat is symmetrical about the major axis although the heater elements are embedded only in the side protecting the underside of the blade. This enables dummy sections of metal to be sprayed on the top-side to correct within limits both lengthwise and chordwise unbalances, and to bring the final weight within specification. A very limited opportunity for weight removal from the outboard end is offered by the electroplating of the nickel strip: by reversing the current some nickel can be removed.

The solution of the problem of all-weather flying with helicopters is thus not dependent on the development of new technical ideas, it is a question of production. An essentially hand-made component must be produced with high precision, but the number of times the component is balanced must be limited to promote uninterrupted flow through the plant. Napier hope that once the Spraymats are in quantity production, the number of balancing stages will be reduced from twelve to three.

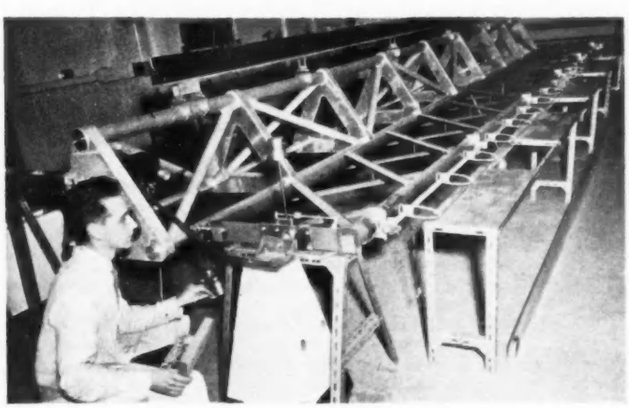


Fig. 1 (above) Vibration and heat cause a powdered-metal resin compound to flow. The compound protects the blades from stones and debris.

Fig. 2 (left) To achieve high precision in hand-produced components, the mats are repeatedly balanced and weighed during production.

Lightweight Pallets Speed Air Freight Movement

A swing tail assembly and lightweight pallets for loading freight have been adopted by Canadair Limited, Montreal, for their turbo-prop freighter, the Canadair Forty Four. The aim was a cargo handling system of low weight and capable of rapid loading and unloading. In fact, a ground turn-round time of one hour has been achieved, compared with the five hours that would be needed by conventional piece-loading. The Forty Four can be unloaded and reloaded within the period needed for fuelling.

As the illustration shows, the tail assembly of the Forty Four swings open to give access to the main cargo hold and underfloor space. Use of thick, heavy pallets riding on weighty rollers set in the floor of the main hold—as used in many military aircraft—could not be offered to a commercial operator because of the serious losses in capacity and payload. So a lightweight system was developed. Each pallet consists of aircraft-quality plywood with aluminium sheets bonded to both faces, and aluminium edge fittings. On the underside of the pallet are riveted aluminium strips which slide on dry-lubricant-impregnated nylon runners fixed to the aircraft floor.

Each pallet is ½ in thick and weighs 140 lb, being able to support 8,000 lb. This compares with pallets of 4 in thickness weighing 400 lb.

Channel members on each side of the fuselage floor act as locating guide-rails during loading and prevent the pallet moving under normal flight loads. The pallet loads are restrained by barrier nets, which take up to 9*g*.

Lightweight pallets bring with them certain problems. A special loading platform had to be developed to ensure that they were correctly aligned as they entered the aircraft and not subjected to bending or point loads. When attached to the aircraft, the platform becomes an extension to the fuselage, moving with it under all conditions of changing aircraft attitude caused by varying fuelling loads, oleo leg movements, gust loads on the open tail, and cargo movements in the hold.

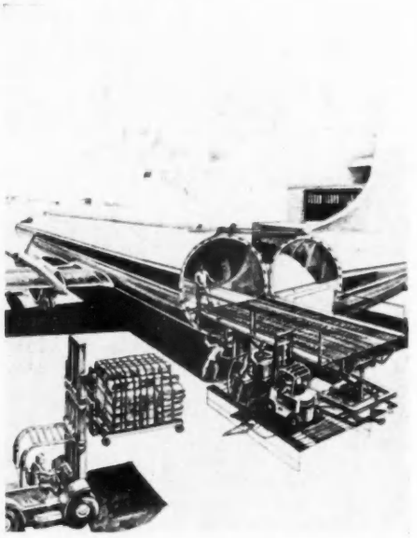
The platform has two levels. The upper level is used for transference of pallets and the lower for underfloor bins. Rubber buffers on the forward face of the platform are the only direct contact it has with the aircraft. Platform locating lugs are locked to the truss by pins, and adjustments for final lateral and vertical positioning are by screw-jacks. The platform front supports are counterbalanced to a relief load of up to 1,000 lb. Once in position, the platform is steadied by two pads which are lowered at the rear.

The two-level cargo transfer platform is supported on its chassis by a single ball joint at the rear. The ball joint incorporates a self-levelling jack and the combination compensates for aircraft deflections during loading and servicing operations.

With the transfer platform attached and levelled for loading, a fork-lift truck, overhead monorail, or loading bridge is used to place a pallet on the platform upper level, where a roller conveyor, set slightly above aircraft floor level, allows easy movement of the pallet into the aircraft, until about one-third of its length is inside the open rear fuselage. At this point, spring-loaded hooks automatically engage with pick-up fittings on each side of the pallet. The hooks draw the pallet to a predetermined location in the fuselage. The system then returns the hook carriers to the loading sill to pick up the next pallet.

At the same time cargo bins and containers are placed on the lower level of the platform for loading into the rear underfloor compartment. Handling of cargo on this level is simplified by the use of a ball conveyor and standard roller conveyors on the platform and in the aircraft compartment floor.

To avoid flexing under load and to allow convenient warehouse handling, the lightweight pallets are laid on supporting frames. When loaded, the pallet and frame can be picked up by a fork-lift truck equipped with a special roller-bed attachment. The attachment permits the rollers to project upwards through the frame so that the pallet is supported by the rollers. Pallet stops, which restrain the load in transit, are retracted on reaching the transfer platform and the pallet is rolled on to the deck.



A platform equipped with rollers provides the alignment necessary for the safe loading of the lightweight pallets. The system reduces ground turn-round time to one hour.

Ships' Cargoes Well Distributed by Calculator

Hull damage, particularly in larger vessels, due to incorrect distribution of cargo, is an important factor in ship loading today. As a result, there is a world-wide demand for a rugged, easily operated calculator which can work out hull stress accurately and quickly for every condition of loading.

To meet this demand, the Sperry Gyroscope Company Limited, Great West Road, Brentford, have obtained sole manufacturing and selling rights for a Norwegian device, which will be marketed under the trade name Sperry-SINTEF loading calculator.

The calculator is a robust electrical computer, built up from standard sub-assemblies and not employing valves. The sub-assemblies are arranged for bulkhead mounting in the ship's deck office in a shallow cast alloy case; this is of a length dependent upon the size of the ship. Each calculator is calibrated prior to installation according to the ship's characteristics.

Sperry are offering the calculator in three standard sizes, to suit vessels as follows: cargo ships and small tankers (up to 12 compartments), average modern tankers (13 to 16 compartments), and supertankers (17 to 20 compartments).

Operation of the calculator is self-evident from its control panel appearance. An engraved plan of the ship shows cargo compartments (each with its own tonnage setting knob), surmounted on the left by a selector switch, associated mean draught and shear stress setting knobs and a balance meter used for setting to zero. On the right are similar arrangements for obtaining trim and bending moment.

Trim, bending moment, mean draught and maximum shear stress can be deduced in quick sequence by following a few simple instructions. In essence, these amount to setting cargo tonnage values for each compartment, selecting the information required (starting with trim) adjusting the setting knob to obtain a zero reading on the balance meter, and reading off the required answer on the appropriate graduated dial.

Flow Boom Equipment for Tranmere Tankers

The 30 ft tide range at Tranmere can be easily accommodated by the Flow Booms, which can be luffed through 150°.

At Tranmere a new deep water terminal for berthing oil tankers of up to 65,000 tons has been provided by Shell Refining Company and the Mersey Docks and Harbour Board. There are two jetties, each with a deck level fixed at 27 ft above high water. To cope with a tide range of 30 ft and variations in tanker size, a flow boom structure—produced by Woodfield Rochester Limited, Kent—has been installed on each jetty to handle the 12 in flexible discharge hoses used to unload the tankers.

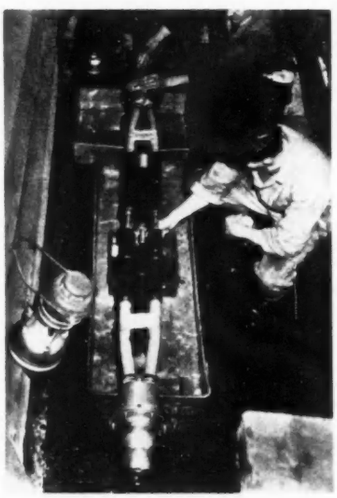
One of the installations is shown in the illustration. Push button control of the flow booms is carried out by an operator situated either at jetty level or in the cabin near the top of the structure. Each of the two installations has six 12 in hoses and their booms can be luffed through 144°. The flow booms are raised and lowered by electric winches of 4 tons capacity. The booms also slew through an arc of 150°, and free motion in this plane is an advantage should the tanker drift along the berthing line.

The manufacturing company consider that the boom-head swivel adopted will increase the life of the rubber hose to a throughput of 12-15 million tons.

Taking 132 kV Cables Under Urban Leicester

To reinforce the electricity supply to the northern part of the city of Leicester, 8,000 yards of duplicate 132 kV underground cable have been installed. The cable runs from Freeman's Meadow power station to a new substation at Blackbird Avenue. It is a 0·60 sq. in 3-core oil-filled cable. Compacted circular copper conductors and aluminium oil ducts are used. The single lead alloy sheath, tin bronze reinforced, and the protective serving give the cable an overall diameter of 4·85 in. Combined pilot and telephone cables are laid alongside the feeders.

The contract, valued at over £100,000, was awarded to AEI Construction (Cables and Lines) Division, Woolwich, by the East Midlands Electricity Board, who planned the cable route through the streets of Leicester. Following the main thoroughfare for the first part of the route,



the cable passes over two bridges, where space under the pavement is restricted. To isolate and protect the new cables, brick chases, three bricks deep, were constructed over the bridges and the 132 kV cables bedded in a layer of sand in them. On a further covering of sand in the chases were laid the pilots. When the chases were filled with sand, ½ in steel plates were placed over them, just beneath pavement level.

At three road intersections, headings were driven for cable tunnels to avoid dislocation of heavy traffic. One of the headings required excavations about 14 ft deep. Earthenware pipes were laid in the tunnels, the excavations being filled in with concrete afterwards.

Some 30 joints were made in the oil-filled cables during the course of the cable laying. Jointing must continue non-stop once work has started at any particular joint bay, and there is more than a full 24 hours' work in a straight-through 3 core joint for this type of cable. One of these joints is shown in the illustration.

Massive Communication for Mass Gymnastics

One branch of engineering that countries behind the Iron Curtain have fostered with particular care is that associated with mass communication. Consider, for example, the equipment installed for the Second National Spartakiade held in Prague this summer. A most intricate system for guidance and surveillance was produced.

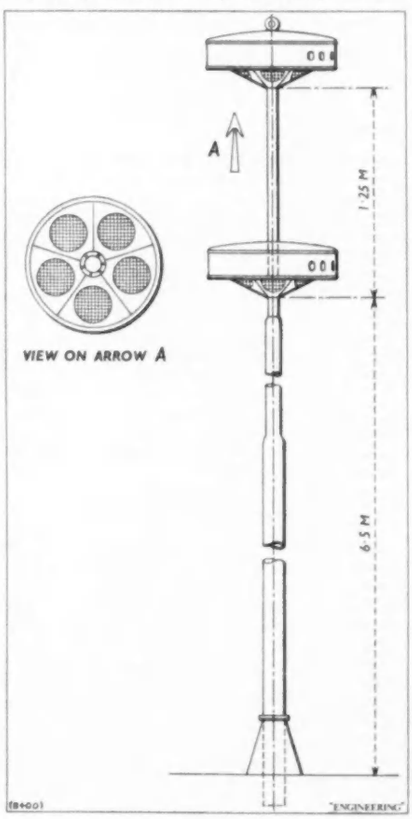
The Strahov stadium, where the regiments of gymnasts went through their paces, covers a total area of 120 acres. During the 10 day meeting some 700,000 gymnasts did their bit. It was not uncommon for 15,000 gymnasts to be performing together in the main 15 acre field; while at the peak of the festival 32,000 women gymnasts appeared in a single display. To keep everyone in step, a special system of synchronous magnetic tape recorders was installed, feeding 20 kW to 3,400 loudspeakers.

The loudspeakers were mounted in 850 combination units: 230 acoustic dipoles, 34 prismatic columns, 112 loudspeakers buried in the ground, and 430 cabinet loudspeakers. It was the main athletic field that was supplied with sound from the loudspeakers buried in the ground. Each of the units was fitted with a case to protect it from adverse climatic conditions and the entry of water. And in case some of the heavyweights started throwing their weight about, the protective structure of the speakers was designed to support a load of 45 tons. The 112 units ensured a uniform distribution of sound over the whole field. They were supplied through 12 separate circuits.

The prismatic columns served the large spaces in front of the main grandstands. Each column contained five loudspeakers connected in phase, with a total input of 25W. The acoustic dipoles served other areas and consisted of two sets of loudspeakers arranged one above the other, as shown in the illustration. Each set contained five loudspeakers arranged in a disc. The two discs were connected in opposite phase, with a total input of 32W. The whole area of the stadium was divided into 63 groups and loudspeaker loops, controlled from a central programme office.

On hand also were 100 portable transistorised loud-hailers for controlling the gymnasts in cloakrooms and smaller spaces. Transistorised receivers of pocket size were used for the quiet transmission of orders to certain group leaders. For intercommunication between group leaders, and between group leaders and the Director, about 30 important points in the area were equipped with quiet and loudspeaking telephones. The control units for these were made up in the shape of portable desks, about the size of a portable typewriter.

To further assist the director and his staff in guiding the proceedings smoothly on their



way, industrial television was used to present a picture of events at certain key points. Both cable and wireless transmission was used. Five cameras fitted with pan and tilt units were installed, the equipment being semi-transitorised. From the director's office it was possible to observe either a single spot on several monitors or to project the scene at each spot on a different monitor. Panning and tilting of the cameras was carried out by remote control, the possible extent of the two motions being 330° and 100° respectively.

Hanging Microphones in the Council Chamber

Putting modern engineering equipment into old buildings often brings problems. One of the difficulties in fitting a system of microphones in the chamber of the Hampshire County Council was that wires had to go through the ceiling. The holes for them had to be positioned accurately and damage to the ceiling by holes in the wrong place could not be tolerated. It was impossible to drill from above with sufficient accuracy. Scaffolding for close drilling from below could not be installed because of risk of

damage to the permanent seats. And the chamber was liable to be used during the operations.

The council had decided to install a sound system because of the increasing noise from heavy traffic passing Winchester Castle, where the chamber is situated. Several experimental installations were tried. The one finally adopted was produced as a result of cooperation between the local electrical contractors, Dicks Limited, and Philips Electrical Limited. A total of 40 microphones are suspended 6 ft 6 in above floor level; they feed through a control panel to a 20 W amplifier and two sound columns.

The problem of drilling the ceiling was finally solved by fixing a bradawl to the top of a 2 in aerial pole. A plumb line from the top of the pole was cut to a length that placed the plumb bob at the level the microphone should be. By holding the pole just slightly off the vertical, it was possible to move it about until the plumb bob was hanging where the microphone was required. All that was needed then was a quick jab with the bradawl to start the hole. After that it was just a question of finishing the hole.

The whole microphone layout has been planned to provide one microphone to about every two seats. How the system looks is shown in the illustration. A control panel has been installed in a raised position at the back of the chamber. The operator, one of the council's committee clerks, switches in the microphone nearest the speaker. Light metal rods and wires prevent the microphones from swaying out of place.

Only two sound columns are used, being placed 10 ft up the wall on either side of the chairman's seat and angled downwards. The operator, as well as deciding which microphones to switch on, also controls the volume according to the strength of the speaker's voice.

On the Shelf

By Frank H. Smith

HERE is one of those occasions when you could slap me down with a barely damp sponge. Some time ago, the library with which I have the honour to be associated (it says here) gave permission for one of its old prints to be reproduced in an American glossy prestige magazine. Now some publishing crowd in New York write and tell me they are preparing some kids' books and request permission to reproduce the picture. " Naturally, you will receive full credit and acknowledgment," and they then rush on, almost without breath-takes, " Thank you very much for your cooperation in this matter. We are most grateful for your assistance." Dammit, I haven't said yes yet, and I shall tell 'em so in the inimitable Smith fashion. Not even an " in anticipation "! Brash lot. I'll tell 'em. That's the trouble with people who feel they are giving the world a message (newspapers, broadcasters both ear and eye, free-lancers and so on); they feel they have a sort of skeleton key in their job and no lock can stand up to it. If you give them facilities they lay about them right and left and very often leave the place a shambles behind them. They cannot differentiate between rights and privileges. I suppose it is a result of living in a world where their own work is tomorrow's fish and chip wrapping or, in another case, at the whim of any child who can turn a knob. It's an occupational trend.

An interesting leaflet on the purchase of American books comes from Mark Paterson and Company Limited (Beech House, 34 Beech Street, Barbican, London, EC1—MOOrgate 9651). It would seem that they buy books from " the other side " not only for the individual but also for some of the bigger booksellers and for Government departments. Their pamphlet is well worth studying since it gives particulars of their information service, method of invoicing and payment, etc.

The Universal Asbestos Manufacturing Company Limited (Tolpits, Watford, Herts.) are all agog to spread the light about asbestos. If you wish to carry a torch for them I suggest you write for their literature.

Aluminium Laboratories Limited, of Southam Road, Banbury, do quite a nice line in reprints of articles printed in journals. Why not ask them all about it?

Mark Paterson (the American agents I mentioned earlier) send the lists of The Shoe String Press Inc. (how quaint can one get?) and two items there catch my librarian eye. *Twenty-five short cases in Library Personnel Administration* by Shaffer at 30*s* (or maybe it's $30 ?) and *Classification with particular reference to Library of Congress classification* at no price at all. Those are both forthcomings and already available are *The uses of Bibliography to the Students of Literature and History*, by Willoughby at 25 units (dollars or bobs) and *Books, Libraries, Librarians* (Marshall, Shirley and Shores) at 48.

A list in little teeny-weeny print is available from the Ministry of Power, Safety in Mines Research Establishment, Portobello Street, Sheffield 1, of establishment publications. 190 of them reports, 86 papers and one or two odds and ends.

Pitman (Parker Street, London, WC2) have a special booklet giving titles on Management. This includes the publications of the British Institute of Management, which can only be obtained from BIM at 80 Fetter Lane, London, EC4. This sharing of one brochure reminds one of that advertisement on the UndergrounD where three separate advertisements for breadrolls, mustard and frankfurters go to make an ad for hot dogs. This sort of thing has endless possibilities. If ENGINEERING combined with *Punch* on the basis of " Why not have a laugh on Wednesday *and* on Friday " I am sure the sales of both would benefit.

Tales from the Arabian Nile

Sun and Shadow at Aswan. By HERBERT ADDISON. *Chapman and Hall.* (18*s*)

On most civil engineering constructional jobs an evening is often pleasantly spent in recalling events and persons connected with the job and describing their notable aspects, whether of technical, financial, human or other character.

Of all works that might be so discussed there is none that provides better material than the major dam of the world's second longest river; and Mr. Herbert Addison, who for many years taught hydraulic engineering to Egyptian university students, is highly qualified to discuss the subject. His book would have remained attractive to readers of several kinds, even had there never been a proposal for a High Dam, with all that has followed thereon, internationally and politically.

The town of Aswan dates back to antiquity, but it is only the last hundred years that need to be surveyed in connection with the existing or the proposed dam. It was not until 1862 that Speke discovered Lake Victoria, although 19 years earlier French engineers led by Mougel had initiated the construction north of Cairo of a low dam, which was to control, in seasons of low flow, the surface level of the river and enable the flow to be divided between the canals of the deltaic lands stretching to the Mediterranean.

The history of the Delta Barrage, built in a hurry and unsuccessfully on a foundation of sand, abandoned, restored to use by British engineers, improved and finally replaced in 1939 by a new barrage surely provides good material for still another book by Mr. Addison. But the interesting features would probably be technical, sociological or economic in character, without any background of outbursts of personal or national emotion such as is now depicted in connection with the dams at Aswan.

The Barrage could however only distribute such water as reached it from the Sudan. It had no storage facilities that would enable it to counteract to some extent the great variations from month to month in the quantities of water arriving there. Nevertheless, the equitable distribution within the Delta of whatever supply there was had yielded such economic and social benefit as to stimulate a determination in the Egyptian Government to obtain storage facilities elsewhere in the Nile valley. The choice of a site for a dam fell upon Aswan, well within the southern frontier of Egypt, at a time when, let it be recalled, the Sudan was independent of and hostile towards its northern neighbour.

Nothing that has happened since those days, some 60 odd years ago, has done anything to upset the choice of site then made, however possible or desirable it has now become to complement the Aswan reservoir with others in various parts of the Sudan and in other territories to the south, as well as with a canal that can convey the water of the White Nile towards Khartoum without its suffering heavy losses in the vast swamp regions south of Malakal.

Despite the soundness of the choice of Aswan then made, the story told by Mr. Addison is indeed amazing in its rapid and numerous alternations of sunshine and shadow. The incidents described include an international commission of dam-engineers who became at loggerheads with each other about the immersion of the temple of Philae; the competition between the Egyptian Army under General Kitchener, eager to reconquer the Sudan, and the Egyptian Public Works Ministry for funds which their Government was even so unable to provide; the ingenious scheme for the financing of the construction of the dam by a British banker, Sir Ernest Cassel, who was a Jew, as should be remembered in these days when the Suez Canal is barred to Israeli vessels; the building (1898-1902) of the original dam by Sir John Aird; the subsequent erosion of the rocky river bed below the dam, and its correction; the first proposal for a thickening and raising of the dam, much criticised by a mathematician and a statistician of London University; the problem of marrying old and new masonry in the face of great variations of air, water and masonry temperatures; the execution (1907-12) of the work; the Willcocks-Kennedy campaign from 1918 onwards against the Nile Basin projects of the Egyptian Public Works Ministry, whose Adviser was Sir Murdoch MacDonald; the investigation (1919) by six eminent British engineers and scientists; a second investigation (1920) by an Anglo-American commission of two engineers and a scientist; the rejection by both bodies of the assertions made in the campaign; the renewal of the campaign by Sir William Willcocks and his trial for criminal libel in a consular court; the proposal for a second raising of the dam; the international commission of expert engineers; the award (1929) of the contract for construction to a British firm; its tragic personal sequel (1930); the appointment of another British contractor; and the successful conclusion (1934) of the second heightening.

A story so vivid and kaleidoscopic is already worthy of addition to the chronicles of Shahrazad's Arabian Nights, but there is much more yet to be told! The need for extra food production for a rapidly growing population, the risk of devastation of the intensified development of the country by river floods and the urge towards its greater industrialisation led to numerous engineering schemes being prepared, of which the boldest was that of a Greek named Daninos. His plan called for a reservoir capable of coping with the vagaries of climate and river flow during any hundred year period and not merely that of the last hundred years, to which most relevant records naturally related. It called too for facilities for the permanent retention within the reservoir of much of that water-borne material which hitherto had never been detained at Aswan when the river flow was large. This gigantic scheme required a dam five times higher than the existing one and of a different design, while the reservoir would be 26 times more capacious! These considerations and the need to maintain the present dam and reservoir in operation until the High Dam was built dictated that the latter should be a completely separate structure built a few miles upstream.

At this point political considerations became all-important. The monarchy was replaced by a republican government to which the idea of the High Dam as outlined above appealed very strongly on several grounds. President Abd-al-Gamal Nasser adopted it and sought among the Great Powers and the World Bank for the funds required, about £200 million. In 1954 the opinion of a body of non-Egyptian experts was once again sought. By 1956 a British consulting engineer had been appointed to supervise the constructional work when it began, while agreement with the scheme was sought from the new Republic of the Sudan. The scene seemed once again bathed in sunshine when suddenly American and British offers or half-offers of financial help were withdrawn. President Nasser in retaliation seized the Suez Canal. Only a few months later Israel made a military attack on Egypt, which led to an attempted seizure of the canal by Britain and France. The Sudan meanwhile was exploring by modern methods of computation the value of numerous combinations of possible reservoir sites in the Nile basin, including that of the High Dam, before expressing its views about Egypt's project. More recently we have seen Russia making credits available for the first stage of work on the High Dam and suggesting changes in its mode of construction.

Mr. Addison's account of the fortunes, constantly varying from good to evil and back again, of engineering work at Aswan reproduces a pulsating violence, such as that of light, colour, heat and human passion which Britons associate with the Nile valley, a violence which in the matter of the two dams derives much of its strength from the fact which the first Lord

Rosebery once stated so pungently: "The Nile is Egypt; Egypt is the Nile."

As if this would not suffice, the author has—on advice, he tells us—added to his story speculations on several philosophical questions, sometimes illustrated by events at Aswan and elsewhere in the Nile valley and often comparing the man of action such as James Watt with the man of thought such as Rousseau. Much trouble is taken to uphold the engineer as a benefactor of mankind, in defiance of the Reith lectures of Professor Arnold Toynbee some years ago and the writings of Mrs. Jacquetta Hawkes. Discussion is sometimes framed in the form of questions, whether they be answered or not, although interrogatory treatment is perhaps better suited to the spoken rather than the written word.

As the course of events at Aswan would show, each single event in an engineering achievement evolves from the balancing of a number of considerations and leads to several results, not always mutually harmonious or beneficial. It can well be a mistake to pick out one of the results and in the light of it to pass judgment upon either the event or its apparent originator. The engineer who wishes to reassure himself about the merits of his calling and his place in the universe will do well to remember not so much the views of Toynbee and Mrs. Hawkes as utterances such as Sir Maurice Bowra's Graham Clark Lecture, "The Impact of Engineering on Society" (*Proc. Inst. C.E.*, Part I, vol. 5, pp. 633-644, Sept., 1956), and Professor Hardy Cross's *Engineers and Ivory Towers* (McGraw-Hill, London, 1952).

It is society and not its tool, the engineer, who decides the extent to, and the way in which, engineering science shall be used, as for example, whether a rocket shall serve as a war-weapon or for the survey of space or shall never be manufactured. The average engineer, provided that he feels that he has chosen a congenial profession and does with his might whatsoever he findeth to do, will in the pursuit of happiness be well advised to spend some of his time steeling himself against the disappointments which society, his master, may cause him by vacillation or calling for a halt in his work or by misapplying it when it is completed. This he can learn to do largely by looking at things "from the other chap's point of view," it being understood that the "other chap" is everyone except the engineer. For this purpose his reading may include for example both *The Economist* and a good novel. A broad approach to affairs such as this is surely inherent in the concept of a university, and it is behaviour which most universities today try to encourage. Unhappily it is also something which a number of engineering students at those places of learning are inclined to avoid. In a residential university they can then be over-apt to huddle together in hall or in the common-room and to "talk shop" unceasingly.

In mediaeval times the undergraduate had first to learn grammar, which was the art of exposition or, as might be said today, how to "put things over" to someone else. To do this he would naturally need to understand that other persons' mentality and approach to affairs. This is a requirement which a technically first-class engineer is sometimes seen to lack, which may be the explanation of the conspicuous absence of the engineer from the boards of some industrial firms. Even so, the engineer is not alone in this shortcoming. A management consultant has said recently that at least nine out of every ten cases of failure in executive jobs in industry are due to social reasons, not technical incompetence (*The Times*, London, 27 June, 1960, p. 7).

It is no coincidence that during the British occupation, the prestige of the Egyptian Irrigation Service was at its highest at the same time that its most senior engineer, Sir William Garstin, had won the esteem and confidence of the country's virtual ruler, Lord Cromer.

The point is well illustrated by a reference to two Royal Engineers of the past, Sir Edward Raban and Lord Kitchener of Khartoum. Sir Edward became civil engineer-in-chief of the Admiralty and as such had to discuss his annual budget proposals with parliamentary committees. When these laymen fired questions at him, it was a common event for him, having anticipated the civilian reaction to an item, to produce on the spot from a portfolio and to hand round copies of a statement supplying the required answer. On the other hand, Lord Kitchener, when he joined the Cabinet during the First World War, expected to have his opinions swallowed without question at their meetings, regarded any doubting minister with amazement, and in the end lapsed into silence, leaving it to the Prime Minister (Mr. Asquith) to present his arguments verbally for him.

However much there be of James Watt, of Jean Jacques Rousseau, or of both of them, in each of us, whether we be engineers or not, Mr. Addison's book much deserves our attention. It is a story not only of material struggle, achievement and development but also of human vision, skill, determination, disappointment, flexibility and hopefulness. It is a story also to be borne in mind by those who live through the next few decades and watch the progress of the High Dam scheme, as well as by all those who may themselves have to endure the buffets of fortune.

W. ALLARD.

Holes in the Ground—Faster

Proceedings of the Symposium on Shaft Sinking and Tunnelling, Olympia, London, 15th, 16th and 17th July, 1959. *The Institution of Mining Engineers, 3 Grosvenor Crescent, London, SW1.* (62*s*)

Post-war industrial expansion, following a long period when development in the mines got sadly behind, has caused a tremendous boom in shaft sinking and tunnelling work that is only now slackening off. Mining for all types of mineral—coal, gold, diamonds, iron ore—hydro-electric schemes, road and railway tunnelling have all contributed. With such a concentration of effort on making holes in the ground it was only to be expected that ther should be enormous strides, both in techniques and in recorded rates of performance.

Last summer the Institution of Mining Engineers held a symposium on shaft sinking and tunnelling. Papers were presented by mining engineers from all parts of the world. These papers have now been published, together with the discussions that they provoked. There are papers on shaft-sinking practice in Great Britain, South Africa, Canada, West Germany, Holland, Sweden, France and Poland, on tunnelling in Great Britain, Canada, the United States, West Germany, Belgium and France, together with special papers on Bentonite grouting, cementation, freezing, blasting, the application of method study, shaft planning and some other associated topics. An impressive collection indeed which any mining engineer will want to browse in and select from at his leisure.

One feature of the shaft-sinking boom has been the unofficial but intensive competition between South Africa and the USSR for higher and higher speeds. For some time the target was a thousand feet in a month—a sort of shaft sinkers' four minute mile—but this has now been left behind. It is a little sad that in all this array of shaft sinking and tunnelling experience the only Russian paper is a theoretical one on freezing water-bearing ground. Their performance competition with South Africa is fascinating indeed, and it would have been interesting to have compared accounts of how these stupendous speeds are achieved.

I remember reading in a South African mining journal, shortly after a Russian team had claimed a sinking record, the opinion that a major contribution to the record was the inhuman Russian attitude to their labour force. More recently an article described how high speeds were achieved in South Africa, in a shaft where the broken rock was loaded into the large buckets (hoppits) by hand shovel (this is normally done now by mechanical grab). A large team of men stood in two rings round the hoppit, and while the inner ring emptied their shovels the outer ring loaded theirs with muck from the shaft floor. At a signal the inner ring bent down to load their shovels and the outer ring of men sent the contents of theirs over the top into the hoppit. If at any time a member of the outer ring allowed his shovel or any of its contents to hit a member of the inner ring the two men changed places! Leaving aside name-calling between possible pots and kettles it must be recognised that differing standards of what one may expect of labourers account for some differences in sinking speeds. It would be difficult to measure the effect.

While speeds of around a thousand feet a month have been achieved elsewhere, the best British speeds have been around the 250 to 300 ft mark, even with a team of South African sinking engineers at Parkside. Apart from any consideration of what is the most economic sinking speed, it is interesting to consider reasons for the discrepancy.

To account for the differences we can look at a number of possible reasons:

(*a*) less time worked (for example, idle shifts at week ends);
(*b*) different techniques;
(*c*) different regulations;
(*d*) different levels of "efficiency"; and
(*e*) different geological conditions.

South African shafts are worked continuously, whereas not all English shafts have been. Method study results for Parkside are given by Booth and Watt (session 8), but it is not made clear how many shifts were worked in a week. British practice tends to require at least one shift for week-end maintenance and checking of equipment.

The biggest factor accounting for speed differences is differences in the method of working. There are two main parts to the shaft-sinking operation: digging the hole and lining its sides, usually with a concrete wall. In South Africa these two operations are done at the same time—fully simultaneous sinking and walling. Marsh (session 5) states that at Parkside simultaneous working was planned, but soon makes it clear that the method was only semi-simultaneous. Booth and Watt state that fully simultaneous methods were prevented by statutory rules and Marsh makes several references to regulations.

Different levels of efficiency certainly ac ount for some of the speed difference. The results quoted by Booth and Watt show many delays, while MacConachie's paper (session 1) on South African practice allows for very few. Operations conducted by the same method are carried out more quickly in South Africa than in Britain. There is a high level of organisation in South African shafts. A whole series of shafts is sunk in succession by one team; thus most of the difficulties are ironed out once and for all, and are not repeated at other shafts.

Finally, geological conditions help to determine sinking speed. Where there is water it must be held back (by freezing or cementation) or disposed of; loose ground needs more careful support.

Continued on next page

Undoubtedly, these problems are greater in British shafts.

Using data given in the papers mentioned it is possible to draw up a rough comparison showing how the different speeds arise; a month has been taken as 28 days, but in fact the best efforts are made in 31 day months.

Sinking speed is just one aspect that can be investigated in this fascinating volume, and of course there are many more. In particular, there is a wealth of technical information that must be invaluable to the practising engineer. The book is well indexed and illustrated and there are, of course, many references to other literature.

JOHN LAWRENCE

	South Africa	*Britain*
Sinking ..	0·94 hour per ft	1·42 hours per ft
Walling ..	0·00 hour per ft	0·21 hour per ft
Delays or time unexplained ..	0·06 hour per ft	0·18 hour per ft
	1·00 hour per ft	1·81 hours per ft
Working time ..	672 hours per month	480 hours per month (five day week)
Speed	672 ft per month	265 ft per month

New Books

Beyond the Planet Earth. By KONSTANTIN TSIOLKOVSKY, translated from the Russian by Kenneth Syers. *Pergamon Press.* (15*s*)

Konstantin Tsiolkovsky, "The Father of Space Travel," was a provincial schoolteacher of Borovsk in Russia, born in 1857. Self-educated, he produced a design for liquid-fuelled rocket motors over fifty years ago, and is acknowledged as having paved the way for the sputniks. The present book, a novel of space travel begun in 1896 and published in Russia in 1920, brings to the field a scientific expertise that Verne and Wells lacked.

Symposium on Radioisotopes in Metals Analysis and Testing, June 1959. ASTM Special Technical Publication No. 261. *American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.* (82·75)

Papers presented include accounts of experience in training industrial personnel in radioisotope utilisation, and of the application of neutron activation to the analysis of aluminium and of traces of molybdenum in tungsten.

Introduction to Laplace Transforms for Radio and Electronic Engineers. By W. D. DAY. *Iliffe.* (32*s* 6*d*)

Laplace transforms have moved from the province of the higher mathematician to that of the electrical engineer, and more especially the electronic engineer, only during the past few years, and now find a place in HNC and degree syllabuses. The first five chapters of this book form an intensive home study course, which is followed by an introduction to more advanced texts.

Electrical Engineering Science. By PRESTON R. CLEMENT and WALTER C. JOHNSON. *McGraw-Hill, New York and London.* (74*s*)

An introduction to the field of electrical engineering by way of the basic concepts of electricity and magnetism, this book is intended as a foundation for such subsequent courses as electronic circuits, energy conversion, and advanced network analysis.

Métrologie Appliquée. By M. DENIS-PAPIN, J. VALLOT and A. FOUILLE. 3e édition. *Dunod, 92 rue Bonaparte, Paris 6.* (580 *Frs.*)

A pocket reference book in the series *Aide-Mémoires Dunod* devoted to methods and instruments of measurement, including electronic, acoustic, radioactive and ultrasonic methods.

Systems Preliminary Design. By JOSEPH J. JERGER. *D. Van Nostrand Company, Princeton, New Jersey, and London.* (110*s*)

Guided missile systems employ almost every imaginable type of engineering knowledge and skill, and demand a degree of overall coordination infrequently encountered elsewhere. The purpose of the present book is to provide an understanding of the problems and functions of the systems engineer, and to facilitate the broader view.

Progress in Nuclear Energy, Series 7: Medical Sciences. Volume 2. Edited by J. C. BUGHER, J. COURSAGET, and J. F. LOUTIT. *Pergamon Press.* (105*s*)

A collection of papers presented at the Geneva Conference in 1958. The papers emphasise the social aspects of the hazards associated with reactors and chemical processing plants and the radiological protection and treatment of workers. Inhalation risks and recovery, and neutron capture therapy are discussed, and there is an authoritative section on teletherapy.

The Applications of Elliptic Functions. By ALFRED GEORGE GREENHILL. *Dover Publications, New York; Constable, London.* (14*s*)

The author, introducing his edition of 1892, of which this is a reprint, pointed out that the theories of Abel and Jacobi some seventy years earlier had scarcely begun to be included in the ordinary curriculum of mathematical study, and suggested a practical approach, developing the analysis as required for the particular problem in hand.

Institution of Mechanical Engineers: Proceedings of the Automobile Division, 1957-58. *Institution of Mechanical Engineers, 1 Birdcage Walk, London, SW1.* (42*s*)

The latest bound volume of the "Autos" to appear includes papers on body corrosion prevention, air suspension, road worthiness inspection, petrol injection, and hydraulic torque converters in tractors

A Glossary of Metalworking Terms. By H. WINFIELD. *Blackie.* (5*s*)

Primarily aimed at the student taking GCE examinations in metalwork, this is a simple, well-illustrated glossary of general terms.

Fluidisation and Fluid-Particle Systems. By FREDERICK A. ZENZ and DONALD F. OTHMER. *Reinhold, New York; Chapman and Hall, London.* (120*s*)

Originally undertaken to provide a coverage of modern developments in fluid-solids processing, but the research involved led to a survey of nearly every major aspect of fluid-particle technology, with extensive references to the literature.

Thermodynamic Tables and Other Data. Edited by R. W. HAYWOOD. 2nd edition. *Cambridge University Press.* (2*s* 6*d*)

A useful compilation of tables drawn from a number of sources and gathered here in a small compass.

Structural Mechanics. By SAMUEL T. CARPENTER. *Wiley, New York; Chapman and Hall, London.* (76*s*)

Primarily intended for use at undergraduate level, a number of the modern topics may yet be of value to graduate students as well as to practising engineers. Numerical methods, finite difference approximations, buckling and combined beam-column action are covered at some length, and extensive use is made of the tools of mathematical analysis.

The Story of Engineering. By JAMES KIP FINCH. *Doubleday and Company, Garden City, New York.* ($1·45)

Dean Finch gives an outline history of 50 centuries of engineering, of necessity weighted towards the civil branch, but also devoting space to the mechanical, electrical and chemical. A substantial paperback of over 500 pages, illustrated with photographs and line drawings.

Guide to the Coalfields, 1960. Edited by R. H. WALKERDINE and E. G. CORBIN. *Colliery Guardian Company Limited, 30-1 Furnival Street, London, EC4.* (20*s*)

Details of mines, personnel and associations. Reorganisations within the NCB have resulted in extensive revisions in this year's edition of the "Guide," and new sections on NCB brickworks, briquetting plants, and coke ovens are included.

Design of Modern Steel Structures. By LINTON E. GRINTER. 2nd edition. *Macmillan, New York and London.* (45*s* 6*d*)

Together with its companion volume, *Theory of Modern Steel Structures*, Volume 1, this text is intended to cover all the problems that can be treated to advantage in the undergraduate courses in statically determinate structures. The study of joints and connections is followed by members, and four chapters are given over to important structures as major design examples: a building girder, a roof truss, a low-truss highway bridge, and a multi-storey office building.

The Reviewers

Mr. W. Allard, O.B.E., B.Sc., M.I.C.E., M.Inst.W.E., is at present engaged as a consulting engineer. From 1910 to 1927 he was employed by the Egyptian Government Irrigation Service, including a period of military duties (1915-19), work in the Sudan (1919-20) and secretaryship of the Nile Waters Commission (1925). He was director of the Iraqui Government Irrigation Service from 1927 to 1934 and engineer-in-charge of the British Surface Water Survey from 1935 to 1954. Since 1957 he has been vice-president, International Association of Hydrology.

Dr. J. R. Lawrence, B.Sc.(Eng.), serves in the Operational Research Group of the National Coal Board. He is a civil engineer and a member of the Operational Research Society.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Instruments

Instruments. VENNER ELECTRONICS LTD., Kingston By-Pass, New Malden, Surrey. Instruments for time, frequency and counting measurements; dividers and power supplies. Illustrated 15-page catalogue.

Delay Unit. ELECTRICAL REMOTE CONTROL CO. LTD., Elrmeco Works, Harlow New Town, Essex. Solenoid operated mechanical escapement type SE delay units; versions from 1 second to 5 minutes. Leaflet.

Flow Measurement. GEORGE KENT LTD., Luton, Beds. The "Commander" series of flow-measuring instruments, recorders, indicators, integrators, controllers and transmitters. Publication 988.

Power Line Alarm. THOS. W. WARD LTD., Albion Works, Sheffield. The Forward ElectroAlarm for fitting to crane jibs to give warning of proximity of overhead power lines. Leaflet.

Data Processing. IBM UNITED KINGDOM LTD., 101 Wigmore Street, London, W1. "An Introduction to Data Processing" gives notes on what it is and how it can help industry.

Salinity Indicator. ELECTRONIC SWITCHGEAR (LONDON) LTD., Works Road, Letchworth, Herts. Salinity-indicating and control equipment for marine distillation plant and feed water systems. Details given in bulletin MSEd1.

Computer. INTERNATIONAL COMPUTERS AND TABULATORS LTD., 149 Park Lane, London, W1. The 1301 electronic computer for data processing is fully described in a booklet. Section one is for the layman; section two is semitechnical and section three is a detailed specification.

Data Transmission. AUTOMATIC TELEPHONE AND ELECTRIC CO. LTD., Strowger House, Arundel Street, London, WC2. High-speed data transmission over telephone lines. Illustrated brochure.

Ammeters and Voltmeters. RECORD ELECTRICAL CO. LTD., Broadheath, Altrincham, Cheshire. "Circscale" miniature moving coil and moving iron ammeters and voltmeters; also edgewise moving coil instruments. Three leaflets.

Caliper Gauge. CAROBRONZE LTD., School Road, Belmont Road, London, W4. "Quicktest" dial caliper gauges for internal and external measurement; a great many models with a wide range of reach and capacity. Leaflet.

Oscillator. DAWE INSTRUMENTS LTD., 99-101 Uxbridge Road, Ealing, London, W5. Ultra-low-frequency oscillator from 0·01 c/s to 1,000 c/s to within 3 per cent. Leaflet.

Marketing

Brightening Up Brittany

ONE of the big problems facing the French is the growth of Paris and the decline in importance of the provincial centres. Ever since the war, Paris has acted as a magnet drawing in new firms and factories and pushing further out into the country. Now strenuous attempts are being made to build up industry elsewhere.

Nowhere are the plans being pressed forward more rapidly than in Brittany. There a central committee has laid down clear objectives for agricultural and industrial production and the general improvement of facilities. So far, Brittany has lived off its vegetables, fruit, dairy produce, meat and fish. What are the likely products of the future? One of the starting points is the barrage of the Rance which will go a long way to solving the energy problems when the Maremotrice power station, and others, are complete.

Rance Barrage

This barrage, which is expected to cost 400 million new francs, will produce 240,000 kW from its power stations. The decision to go ahead with the Rance barrage was not an easy one to take. Natural gas from Lacq in South West France is already piped as far as Nantes. By 1961 it may have reached Rennes. The Bretons have decided to go ahead and not wait.

The industrial centrepiece of the development of Brittany is the Citroen works at Rennes. In 1954 Rennes had 124,000 inhabitants. This is now up around the 150,000 mark and still rising. Citroen began modestly in 1951 with a small factory making ball-bearings and rubber mountings. Today, the company employs 1,600 workers at this factory and their output compares very favourable with those in Paris.

A big new factory is now being built outside the town to turn out car bodies. It is planned to bring out other sections of the Citroen plant from Paris, so that eventually a labour force of 10,000 will be needed at Rennes. All this expansion raises housing problems. In the next two or three years, allowing for re-housing, a total of 60,000 people have to be accommodated. The authorities have a housing programme for 3,000 houses, and 17,000 are being built by private concerns. Elsewhere in the region the main activity is centred on the ports of Brest and Lorient. Both suffer from lack of industrial development in their hinterlands. The former is developing facilities for the repair and refitting of oil tankers. Lorient hopes to become the port of entry for African produce. Certainly if enthusiasm is any guarantee of success the Bretons are going to transform their country in the next few years.

Goods Vehicle Output Booming

Whatever the difficulties of the motor car manufacturers, the goods vehicle producers go from strength to strength.

The most recent figures show that goods vehicle production in June rose to the new level of 9,335 a week with a total for the month of 46,674. Thus the output for the first six months of the year was 226,037 units, about 60,000 more than in the first half of last year.

Motor car production declined from the 34,136 a week high level of May to a weekly average in June of 29,623. But June was a five week month and the final total, 148,114, was the highest ever achieved in one month. The first six months of 1960 the total reached almost 800,000 cars. The first half of 1959 saw a total car production of only 573,769.

More recent figures available from the United States show that passenger cars and trucks produced there in the week ending 22 July was 136,623, compared with 157,016 in the same week of the previous year.

Complete Paint Sytems from New Lysaght Division

A new branch of the JOHN LYSAGHT concern, the LYSAGHT-DEVILBISS division, is now preparing to manufacture complete paint finishing systems, from metal pre-treatment to the final stoving.

The new organisation combines the engineering experience of Lysaght with the highly specialised knowledge of Aerograph-DeVilbiss in the field of designing and producing complete systems. It has emerged from previous cooperation between the two companies. The earlier work has included contracts for finishing plant in the motor industry and in the production of domestic appliances.

Scientific Instrument Sales Rising

Deliveries of scientific and industrial instruments rose by 18 per cent in the first quarter of the year, compared with the same period of 1959. Export deliveries, reported the *Board of Trade Journal*, rose by 19 per cent.

All the various types of instruments contributed to the gain in trade. Industrial process measuring and control instruments gained 27 per cent, optical instruments 32 per cent and electronic computers 26 per cent.

The reception accorded the recent instrument show in Moscow suggests that the figures for the first quarter may, at least in the export markets, continue improving.

Atomic Authority Sells Beryllium Factory

CONSOLIDATED BERYLLIUM, a company operated by the IMPERIAL SMELTING Corporation, has bought the beryllium works at Milford Haven, Pembrokeshire, from the United Kingdom Atomic Energy Authority.

The price has not been revealed and it is understood that the new owners will continue production of the rare metal, although perhaps on a reduced scale.

The UKAEA is reported as stating that industry is now well equipped to meet the future demand for the metal and to itself be holding sufficient supplies for its purposes.

Beryllium, small quantities of which have been used in X-ray windows, is used in some of the cans for nuclear reactor fuel. Its future rests very much with laboratory findings and the extent to which further applications are found. One of the problems in producing articles of beryllium is the extreme toxicity of the powder and vapour.

The Imperial Smelting Corporation is a subsidiary of the CONSOLIDATED ZINC CORPORATION.

ISHRA Sell Back Two More Concerns

The IRON AND STEEL HOLDING AND REALISATION AGENCY has sold the family steel re-rolling company, W. WESSON, of Wednesbury, Staffordshire, to Mr. L. J. Wesson, the firm's chairman and managing director, and to Mr P. J. Wesson, for £600,000.

The Wesson company, which was founded in 1914, was valued for the nationalisation purposes at £704,838 and compensation stock to this value was issued. Throughout the period of state control members of the Wesson family have served on the board.

The firm has had a consistent record of before tax profits during its nine years as a nationalised steel concern.

ISHRA have also sold to DUPORT Limited the entire share issue capital of the LLANELLY STEEL COMPANY (1907) Limited, together with a loan of £2,160,000 owed by that company to the agency, for £1,750,000.

The headquarters of Duport are at Tipton, Staffordshire. The company is a holding company owning a number of companies well known in the steel and manufacturing industries in the Midlands.

Finland Looking Both Ways

Finland is the little orphan Annie of the West. Apart from the Nordic Council, to which she belongs with the Scandinavians and Iceland, Finland is outside all the international organisations except the UN Economic Commission for Europe, of which she is an Associate Member. The main reason for this state of affairs is Finland's close proximity to the USSR and its very close trading links with that country.

Last year about a quarter of Finland's trade was with Russia and the satellites, 31 per cent was with the EFTA countries, and 29 per cent with the six EEC countries. Trade with the USSR is largely on a bilateral basis. Finland has received credits of 500 million roubles (around £45 million) partly to cover purchases of goods and partly to help in the development of heavy industry. Most of Finland's import trade is now free of quota restrictions. The majority of West European countries have joined the so-called Helsinki Club, a clearing arrangement to enable Finland to trade on a multilateral basis. The division of Europe between the Six and the Seven is a serious problem for Finland. There is no doubt that the Finns would like to join EFTA. Otherwise their timber and paper exporters will have difficulty in keeping up with the Swedes'.

Timber Prices

To match the 1 July tariff cuts of 20 per cent on trade between EFTA countries the Finns are having to lower their timber prices here. The problem facing the Finns has three parts—tariffs, quotas and protection for the home industries. In trading with Russia Finland has to apply the most-favoured-nation clause at Moscow's insistence. This could make difficulties as, if Finland joined EFTA, GATT members would doubtless complain at the USSR, which is not a GATT member, receiving the same treatment as the Seven.

The problem should not prove insoluble as 70 per cent of Finland's imports from the USSR are of coal, grain, sugar, fodder and fertiliser, all of which come in free. Under the new five-year trading agreement made with the USSR, Finland will take about 80 per cent of its oil imports from the USSR. If industrial exports from the USSR should increase in volume the position might be more difficult to solve from the EFTA countries' point of view. The other question is the desire of the Finns to protect their own industries. Small scale industry is particularly vulnerable, especially wool, leather and light metal goods.

If Finland joined EFTA and British, Swedish and Swiss products came in at lower tariff rates there is no doubt that many small firms would feel the pinch. At the moment the prospects of Finnish participation do not look too bright. Political troubles at home and uncertainties about Mr. Kruschev's intentions all make the situation very obscure.

But, as the Finns realise better than anybody, if they stay outside EFTA they are going to see their industrial development and living standards drop steadily behind those of their Scandinavian neighbours. And that is not a prospect that a small isolated nation can contemplate with anything but foreboding.

£700,000 AEI Contract in Australia

Direct current motors ranging in output from 600 to 2,500 h.p., giving a total power availability of 17,700 h.p. are to be provided by ASSOCIATED ELECTRICAL INDUSTRIES Heavy Plant Division under a £700,000 contract, obtained from the BROKEN HILL Proprietary Company, for a new rod mill.

The order includes switchgear, control gear, auxiliary drives and other ancillary equipment. Mercury-arc rectifiers, rated at a total of 13,000 kW will supply the mill motors.

The greater part of the electric control equipment is to be made in Australia by AUSTRALIAN ELECTRICAL INDUSTRIES (Proprietary) Limited and the rest of the order will be produced at the Rugby or Manchester (Trafford Park) AEI Works.

£500,000 Switchgear Order for Generating Board

The CENTRAL ELECTRICITY GENERATING BOARD have ordered from ASSOCIATED ELECTRICAL INDUSTRIES Switchgear division the circuit-breakers, switches, control and relay panels and connection materials for the new switching station at Brinsworth, near Sheffield. The switchgear will be worth some £500,000. The new switching station will provide for new steelworks projects in the area.

Principal items will be produced at the Willesden and Higher Openshaw works of the Switchgear division. The commissioning of the installation is due to take place in the spring of 1962.

The gear includes seven 275 kV enticular tank oil circuit-breakers, twenty isolating switches, six earthing switches, control and relay panels, and connection materials for the outdoor equipment.

Telescopic Drilling Rig Saves Manpower

One of the 15 mobile tower drilling rigs for Russia undergoing trials, fully extended, in a Derbyshire quarry.

The mobile tracked tower drilling rig shown in the illustration, is revolutionary in that the four medium-weight drills, or drifters, can be operated simultaneously by only two men without fatigue over long periods. Intended for use over a large working face, the drifters are capable of drilling through rock to a depth of 13 ft simultaneously, at any height from ground level up to 32 ft above. Maximum horizontal span between the outermost drifters is 24 ft.

The telescopic tower and the booms carrying the drifters are hydraulically operated from a 7½ h.p. motor-driven pumping set on the main chassis. The tower itself consists of five nesting sections linked to the hydraulic system through wire ropes and pulleys, and can be collapsed to a height of 11 ft. It is mounted on a pair of tracks driven by a 40 h.p. electric motor, enabling it to negotiate rough and uneven ground, and during the course of recent tests a gradient of 1 in 7 was successfully tackled.

Each drifter consists of a Holman Brothers Limited medium weight SL 280 drill mounted on a power feed cradle. Crowding rams of 30 in stroke are provided so that the feed cradle can be pushed right up to the rock face. The rig illustrated is one of 15 currently being exported to Russia for mining purposes, where the drilled holes will vary between horizontal and an angle of 30 degrees. Using 2¼ in tungsten carbide tipped "Holbits," drilling speeds of 16 in per minute are expected.

All movements of the machine are controlled from panels on the drill platform, and to operate the drifters an independent compressed air supply of about 700 cu. ft per minute is required.

The machine was designed and built by the Climax Rock Drill and Engineering Company Limited (a subsidiary of the Holman group), Carn Brea, Cornwall, in conjunction with F. Taylor and Sons (Manchester) Limited, Bolton Road, Salford, Lancashire.

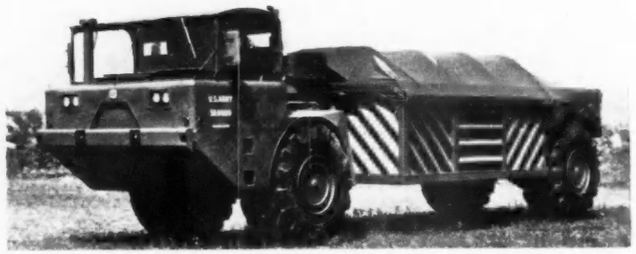
The Goer: A Heavy Go-Anywhere Military Vehicle

Because of the weapons of widespread destruction now available, military planners realise that the future army must be supplied with vehicles having cross-country mobility. The US Army therefore commissioned Le Tourneau-Westinghouse Company, of Peoria, Illinois, to produce a suitable vehicle, capable of operation quite independent of normal highways.

Known as the "Goer," the new vehicle is really a ploughshare changed into a sword. It uses proved components which have been tried and tested by many years of service in the field of earthmoving. The two wheel prime mover, articulated electric steering, high ground clearance, springless suspension, rugged power train and large diameter rubber tyred wheels are all in common use in earthmoving equipment. Two prototype models have been constructed, one is able to carry 5,000 gallons of fuel and the other 15 tons of cargo. Both are buoyant in water for crossing rivers and lakes.

Each vehicle is a semi-trailer unit, steering being carried out by rotating the whole front section by an electric motor. As the maximum rotation is 90° either side of the straight ahead position, a very small turning radius is possible. Total reduction between the steering motor and the internal ring gear on the tractor is 975 to 1, and a solenoid-operated steering brake is applied automatically whenever the steering wheel is not being turned.

The front section also forms the tractor unit with a Detroit Diesel 8V-71 engine rated at 274 h.p. at 2,300 r.p.m. From the engine the drive passes through a manual two-plate clutch to an air-operated five-speed gearbox under push button control, synchronisation being automatic. The clutch is only used when starting from rest.



The cargo version of the Goer, capable of traversing rough country and water.

While the front wheels of the machine are driven directly by the engine, the rear wheels can be driven by an electric motor powered by a 3-phase a.c. generator also coupled to the engine. Maximum generator output is 518V at 200 cycles. The rear wheel drive only operates in the low gear and the reverse gear ranges, otherwise propulsion of the Goer both on land and in water is by the front wheels alone.

Braking is by 22 in diameter multiple disc brakes, air-operated and fitted to all four wheels. A total brake area of 3,840 sq. in has been provided. When braking on a long downhill gradient it is possible to use the electric generator as a dynamic brake, the electrical energy being dissipated through grids on the top of the transmission unit.

The tyres have a diameter of 6 ft and work at a pressure of 25 lb per sq. in. Apart from their cushioning effect no other springing is used.

Maximum speed of the Goer when travelling on a road surface is just over 30 m.p.h. In water, using the front tyres as a form of paddle wheel propulsion, the speed is 3½ m.p.h., and it is planned to add a hydrojet to improve this.

The vehicles at present constructed have a range of about 300 miles. An extensive testing programme is now being carried out with a view to further development.

Rubber-Sleeve Flexible Shaft Coupling

A new flexible shaft coupling, the Quadriflex, has just been introduced. Its exceptional torsional flexibility—15° at peak torque compared to 1° to 3° or so for other types—and its resulting ability to absorb vibration and shock affords long life for both driving and driven equipment.

The Quadriflex coupling is simple in design, consisting of two steel flanges and a two-piece flexible rubber sleeve. External teeth formed in the flange ends of the sleeve halves lock into internal teeth on the steel flanges without clamps or screws, and are self-tightening under torque. Other advantages of the rubber sleeve design of coupling are already well known, including:

(1) Easy installation which is unaffected by abrasives, dirt or moisture.

(2) There is no metal to metal contact, hence operation is silent.

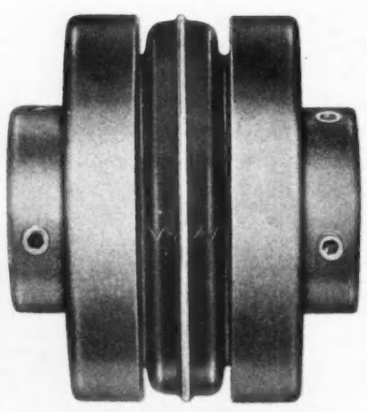
(3) Absence of wear eliminates the need for lubrication or maintenance.

(4) No destructive overhung loads are placed upon driver or driven shafts.

(5) Angular or parallel misalignment does not generate unbalance or pulsations, since all the flexing takes place within the rubber sleeve.

As its name implies, the Quadriflex coupling is designed to cater for all the four degrees of flexibility, namely, angular misalignment up to 1°, parallel misalignment up to $\frac{1}{16}$ in (depending upon shaft size), free end float up to $\frac{3}{8}$ in (depending upon coupling size) and torsional load (vibration, fluctuation and shock).

The Quadriflex coupling has been developed by R. and J. Dick Limited, Greenhead Works, Glasgow. The available duty range is from 0·09 h.p. at 100 r.p.m. to 500 h.p. at 1,750 r.p.m.



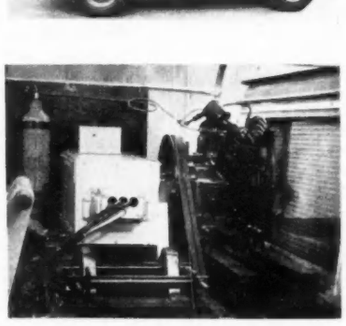
Support Vehicles for Land Record Attempt

When Donald Campbell attacks the land speed record in Bluebird on the Utah Salt Flats, USA, next month, he will be supported by at least ten special vehicles. Most of these have been designed or adapted specially to provide Bluebird's personnel and service requirements during the initial trials and the attempt runs.

One of the rules governing the attempt itself is that the two runs over the test mile in the middle of the course must be made within one hour, the mean between the two runs then being taken as the speed for record purposes. The five primary role vehicles therefore consist of three types, two of which are duplicated so that one of each can be stationed at each end of the course. These comprise two fuelling and two service vehicles and one fire-fighting tender.

The two fuelling vehicles were supplied by British Petroleum Company Limited, and each consists of a Commer truck adapted to carry supplies of Aviation Turbine Kerosene fuel and the various lubricants required in Bluebird. Hand pumps and hoses are also carried, and a strict routine has been developed for the procedure at the end of each run. The primary functions will be to replenish the fuel tank and to change the oil in the transmission cases which would become overheated if used for a second run. To minimise the risk of human error during refuelling, colour coding has been adopted for the vehicle's containers and hose couplings, also the filling points on Bluebird.

Apart from refuelling at the end of each run,



Bluebird must be turned round, jacked up for wheel changing, the brakes cooled, batteries and compressed-air reservoirs recharged and the engine restarted. All these functions are performed by the duplicated service vehicles supplied by the Rover Company Limited, Solihull, Warwickshire, one of which is shown in the accompanying illustrations. Each of these consists of a specially-fitted Land Rover carrying the following items of equipment:

(1) Hydraulic winch.

(2) Air compressor delivering at about 3,000 lb per sq. in for the brake control reservoirs, belt-driven from a central power take-off pulley.

(3) 9 kVa 24 V generator driven off the same pulley to charge the ten special 12 V batteries on the Land Rover. These supply current to Bluebird's engine starter, to the portable hydro-electric power pack used to operate Bluebird's built-in jacking system, and for charging Bluebird's own batteries.

(4) 230 V alternator driven off the same pulley to operate the four fans used to cool Bluebird's brake discs.

Other special fitments include long range fuel tanks, tropical cab roof, and extending sun awnings.

The fire-fighting tender consists of another Land Rover equipped with Pyrene fire equipment. It will patrol the course during the runs. All five Land Rovers have intercom radios for direct communication with Bluebird and the control towers.

For secondary duties Rover (North America) are supplying more Land Rovers. One is equipped as a mobile workshop, while another will be carrying the ground installation of the Didas telemetering system supplied by Sir W. G. Armstrong Whitworth (Aircraft) Limited, Coventry, to relay Bluebird's critical instrument readings while running. Other Land Rovers will be used for transporting personnel.

Bluebird itself is now crated up and in transit to America by sea. Travel from New York across America to the Salt Flats will be by articulated lorry, the tractor unit of which is a modified SD4 produced by Seddon Diesel Vehicles Limited, Oldham, Lancs. Chief departure from the standard SD4 tractor is the provision of a dry air cleaner mounted behind the cab, to protect the 173 b.h.p. diesel engine against the dusty conditions anticipated on the journey.

Improved VHF Television Relay Cables

Two new types of television relay cable, single and double screened, have just been developed in this country. They are designed to meet increasingly stringent specifications with regard to radiation, rejection of extraneous interference and minimising of conductor and dielectric losses. The new cables are small and unobtrusive in service and have excellent high frequency characteristics. Both types incorporate the well known Aeraxial polythene conductor insulation to give low attenuation.

The insulation in the single screened version has a primary screen consisting of longitudinally folded copper tape overlaid with anchoring copper braid. Both are covered by an electrically conductive thermoplastic sheath which has a much higher specific resistance than the underlying metal, and functions as a surface barrier to the longitudinal transfer of radiation, along the outer surface of the copper tape and braid. This conductor layer is protected by a substantial pvc sheath.

The double screened version has an inner screen of close-mesh copper braid applied to an Aeraxial insulated conductor. This is separated by an insulating intersheath from the secondary screen, which is copper tape, longitudinally folded and overlapped and provided, with an overlying braid, as in the single screened cable. A conductive thermoplastic sheath and protective outer sheath are provided, and the radiation characteristics are even better than the single screened version.

Other electrical characteristics are identical in the two ranges. Both these cables are available in five conductor sizes up to 0·104 in diameter, from Aeralite Limited, Castle Works, Stalybridge, Cheshire. They have very uniform impedance characteristics over the entire range of television bands, and each reel is supplied with certified performance test figures at 50, 100 and 200 megacycles.

Freeing the Obstinate Nut, Bolt or Screw

A new tool now on the market, the American HKP Porter Impakdriver, is intended to free any nut, bolt or screw that has become rusted in, even if the head is badly corroded.

The Impakdriver is held in contact with the head of the screw to be loosened as shown in the upper illustration. It is operated by two cams, which are aligned by twisting the body in one direction or the other, so that a blow on the head of the tool is converted into clockwise or anticlockwise rotational thrust. It is claimed that the mechanism is as sturdy as the tool itself, and not only can the tool loosen screws having right or left hand threads, but it can also be used for tightening.

Each Impakdriver kit costs £3 15*s* and includes the set of bits shown in the lower illustration. Using these, every kind of screw can be tackled.

For nuts and bolts the adapter head is pulled off, exposing a standard ¼ in square male drive which will fit any size of socket spanner head.

Introduced by Foley-Brickley and Partners Limited of 99 Park Lane, London, W1, Impakdriver kits are marketed by E. P. Barrus (Concessionaires) Limited, 12-16 Brunel Road, Acton, London, W3.

Treadle Operated Automatic Service Doors

The service doors between the kitchen and the restaurant at the Skyway Hotel, London Airport, have automatic opening units of unusual design. Each door is electro-pneumatically operated from a floor pad, which is completely recessed in the floor, occupies only 2½ in depth, and operates on a low voltage.

The floor pad combines a robust construction with a high sensitivity. On the kitchen side it can be washed down in the normal manner, while on the restaurant side it is concealed beneath the carpet. After a waiter has initiated the pad by treading on it, the door remains open long enough for him to pass through before reclosing by means of a timer unit. The timer circuit is arranged to reset after each initiating action, thus permitting a succession of waiters to pass through the door before it closes. An important feature associated with this sequence is the immediate reopening action of the door if the pad is depressed after the door has started to close. A selector switch fitted above the door permits selection of any one of three conditions at will, namely automatic, maintained open or manual.

The equipment was specified by the hotel owners on the basis of previous favourable operating experience in Canada, and the reaction of the hotel staff is said to be enthusiastic. Supply and installation was by Radiovisor Parent Limited, Stanhope Works, High Path, London, SW9, and it makes an interesting departure from that firm's well known automatic systems employing a beam of light in conjunction with a photo-electric cell receiver.

Four-Seater Ferrari 250 GT

Quickly following up his crushing victory in the Le Mans 24 hour race, Ferrari launched a new version of the famous 250 GT with two main seats and two occasional seats. All previous models have had two seats. The extra interior space has been obtained without increase of length or wheelbase by moving forward engine and gearbox. The low drag body form incorporates a slightly smaller radiator grille than the other models and a smooth bonnet, without air intake, shaped to a profile which is designed to prevent lift and increase road adherence at high speeds. Fog and spot lamps are incorporated in the radiator air intake. The two-door body by Pinin Farina is of severely simple style with no irrelevant decoration. An almost unbroken expanse of glass gives excellent all round vision. The roof line, extends slightly over the rear window to give adequate head room in the rear seats and the curved rear quarters blend into a new high tail which gives more luggage space than on the two-seater models Rear seats have side and centre arm rests. An intake below the windscreeen feeds fresh warm or cold air to the interior and there are two additional cool air intakes at the front. The side windows drop and the rear quarter lights are hinged.

The engine is the well-known V-12 (73 by 58·8 mm) 2,953 c.c. It has three twin choke carburettors and gives 235 b.h.p. at 7,000 r.p.m. on an 8·8 to 1 compression. Transmission is by four-speed synchromesh gearbox, and a Laycock overdrive is offered for the first time. There are Dunlop disc brakes for all four of the centre lock wire wheels which carry 6·50-15 tyres.

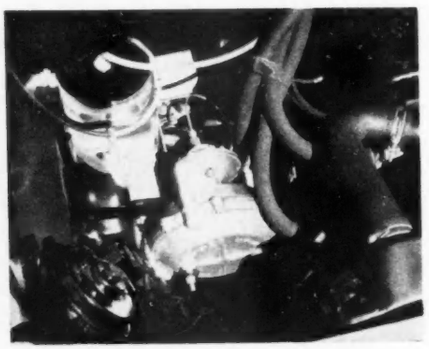
Power Braking for Vauxhall Sixes

Power-assisted braking is now available as an optional extra in the Vauxhall Sixes—the Cresta and the Velox. It is provided by a hydraulic and vacuum servo unit specially designed for the company's six-cylinder models made since October 1957.

The new accessory serves to reduce the pressure required on the brake pedal by half, for example, 45 lb as against a corresponding 90 lb. The compact self-contained unit is mounted on two brackets on the offside of the engine and is powered by vacuum from the induction manifold. A vacuum reservoir is incorporated in the servo, so that two full-power brake applications can be obtained even with the engine stopped.

The United Kingdom price of the power-braking unit is £12 17*s* 6*d*, and the estimated time for fitting is about two hours.

Improved versions of all Vauxhall models are shortly to be introduced. The power-assisted braking attachment will of course be suitable for the six-cylinder models in the new range.



Through the Highlands with Winch and Anchor

In the face of the growing popularity of pony trekking in the Highlands, Austin engineers set out to demonstrate the cross-country abilities of the Austin Gipsy. While expressing no opinion as to the future of motor trekking, Austin are happy to report that their vehicle covered about 1,000 miles cross-country " in the vilest imaginable conditions in the Counties of Ross-shire, Sutherland and Caithness." The actual route from Ullapool to John O'Groats measured 160 miles, the remainder was taken up in finding the route. The exploration confirmed what has been suspected for some time. " For the most part this barely populated area of Britain is a rock-strewn waste interspersed with deep peat bogs, streams and lakes," report Austins.

Borrowing a trawler's anchor, they were able to make the first leg from Ullapool to Lairg in 10 hours. This extensive 20-mile journey through the unspeakable beauty of the Highlands—" large boulders, treacherous gulleys, and swift flowing streams "—was completed to the astonishment of local inhabitants. The Turner front-mounted winch, 150 ft of cable, and the anchor, are confidently recommended to motorists touring this area.

A local feature to be avoided in the north of Scotland is the peat bog. Specimens are often 15 to 20 ft deep. Should the top surface of the turf be in any way cut or torn by the wheels there is little that can be done to prevent the vehicle sinking completely out of sight.

At no time along the cross-country route was the surface found to be level. Satisfactory traction was developed however by the Gipsy's four-wheel drive and independent suspension, which kept each wheel on the ground in all but the most extreme conditions. On narrow sheep tracks on the side of hills, ideas of horizontal driving have to be abandoned. Progress is often only possible by running two wheels along the track and the other two up the side of the hill. The hills are steep and motorists can expect to spend much time at sideways angles departing from the horizontal by as much as 40°.

Plenty of petrol should be carried as filling stations are far from numerous over this route and consumption can be high. In some parts the Gipsy was only doing 7 m.p.g., compared with a normal consumption of about 20 m.p.g.

On the second leg of the tour, between Lairg and Kinbrace, the terrain presents certain difficulties. Small bridges had to be built to span the numerous gullies that are a feature of this part of the world. The terrain on Knockfinn heights is of a nature not recommended to motorists and an alternative route round their flank, via the east coast, is preferred if John O' Groats is to be reached. Caithness road conditions permit speeds of over 40 m.p.h. at times.

Throughout the test the vehicle required no maintenance apart from the checking of petrol, oil, water and tyres. It was considered that the pounding which the all-rubber " Flexitor " suspension received would have broken a conventional leaf spring on many occasions. Subsequent examination of the Gipsy at Longbridge revealed no defect in spite of the brutal punishment received in Scotland.

New Berkeley Three-Wheeler de Luxe

Since the introduction of the Berkeley Three-Wheeler in September last year more than 1,700 have been sold. Now the manufacturers, Berkeley Cars Limited, announce the addition of a de-luxe version.

Many improvements have been made, but the principal modification is increased rear seat accommodation providing more leg-room for children or greater luggage space.

The windscreen has been redesigned to give better visibility and a larger hood has been provided. A hard-top version will be available shortly. A heavy duty front suspension has been incorporated and a reinforced rear suspension utilises a larger spring shock absorber unit and enables a lower sitting position to be provided. The body is constructed of moulded glass fibre, Wheel discs are included as standard.

The Berkeley Three-Wheeler is powered by an Excelsior 328 c.c. twin cylinder engine and drive is to the two front wheels. Top speed is said to be 55 to 60 m.p.h. and manufacturers claim an average petrol consumption of 60 miles per gallon.

Price of the Berkeley Three-Wheeler de-luxe model in England is £425 including purchase tax. The price of the standard three-wheeler remains at £339 19*s* 11*d* including tax.

Fuel Cells: A New Dimension in Power

Theoretically, a primary cell could be based on the electrochemical oxidation of any substance that is thermodynamically unstable in the unoxidised state. Much effort is now being devoted to establish a practical technique which will produce cheap electrical power this way.

By B. C. Lindley, B.Sc.(Eng), Ph.D.

C. A. Parsons Nuclear Research Centre

THE main attraction of the fuel cell is the potentially higher efficiency that can be achieved in the use of fuels, either natural or synthetic, to produce electrical energy, compared with heat engine cycles which are restricted in performance by the Carnot limitation*. With considerable development, electrochemical techniques might replace or complement existing methods of converting chemical into electrical energy, since the high efficiencies are only possible if certain obstacles can be overcome.

Although the principles of the fuel cell have been well understood since the nineteenth century, the successful development has been hampered by technological difficulties, and it is only in recent years that useful performance has been achieved with prototype cells. The presently increased effort on fuel cells is partly due to advances in technology which have prompted a revival of interest and to a realisation that available energy supplies are limited and must be conserved. An additional factor is the increasing demand for power units to meet special requirements, for example, in submarine propulsion, in remote locations such as the polar regions, or in space systems, where fuel cells could have advantages over heat engines or other devices.

FUEL CELL PRINCIPLE

In a fuel cell an oxidant is supplied to a positive electrode and a fuel to a negative electrode. The two electrodes are electrochemically connected through an electrolyte which prevents mixing of the fuel and oxidant but provides an electronically insulating and electrolytically conducting linkage. Fig. 1 shows the basic arrangement. The available chemical energy is the free energy of the reaction

fuel + oxidant → reaction products.

All of the energy can be converted to electrical energy if the reaction is carried out isothermally and reversibly. The production of electricity is the reverse of the familiar process of electrolysis and the reaction products are the same as result from the direct combustion of the fuel and oxidant.

If the chemical reaction is performed non-isothermally with no work done, all the chemical energy will appear as heat. Heat is random in nature and, since work is a directed form of energy, the Carnot limitation applies to the conversion of thermal energy to useful work. To escape this limitation it is necessary to prevent the chemical energy becoming randomized. The chemical reaction will, in a fuel cell, occur in the two parts (half-cell reactions):

cathode reaction : fuel → ions + electrons

anode reaction: oxidant + electrons → ions

The energy is never randomized because the electrons liberated at the cathode flow unidirectionally to the anode through the external circuit, driven by an electromotive force proportional to the available free energy of the reaction, which enables the electrons to do work before reaching the anode.

* The efficiency, η, of a reversible (Carnot cycle) heat engine, working between a heat source at absolute temperature T_1 and rejecting heat at absolute temperature T_0 is $\eta = (T_1 - T_0)/T_1$; no practicle heat engine can have a thermal efficiency exceeding this value.

The available energy in the possible chemical reactions is such that the open circuit voltage of a cell is limited to about 1 volt. As an example, Fig. 2 shows the theoretical open circuit voltage of a cell operating on hydrogen and oxygen, using 27 per cent by weight potassium hydroxide solution as the electrolyte. An increase in pressure raises the voltage; as the temperature is increased the voltage falls. An increase in electrolyte concentration also raises the voltage. The fuel cell must therefore be regarded as a source of direct current at low voltage.

Under load the actual voltage of a cell will be less than the theoretical value because certain requirements cannot be completely fulfilled. The most important requirement is that, at each electrode, only the processes necessary for the main chemical reaction must take place, and the reaction rate must be high enough to yield an acceptably high current density. Losses due to the irreversibility of the electrode reactions, termed activation polarisation, appear in the form of heat. A smaller proportion of the losses are due to cell internal resistance and to concentration polarisation, the latter effect being due to changes in concentration of the electrolyte in the immediate vicinity of each electrode. Fuels and oxidant are usually gaseous and there may therefore be a measurable loss due to diffusion through the electrolyte, with combination at the opposite electrode.

To realise an acceptable capital cost the specific power output of a fuel cell must be high; consequently the current density at the electrodes must be high. The basic problem is to increase the reaction rates at the three-phase boundary between the electrode, electrolyte and fuel or oxidant. This can be achieved by increasing the effective surface area of the reactants, by increasing the temperature and pressure, and by the use of catalysts. Refinements in mechanical design, both in the cell itself and in auxiliaries and fuel storage, can give further improvements.

TYPES OF FUEL CELL

Hydrogen-oxygen cell

Among various attempts to perfect the hydrogen-oxygen cell, the most successful has been the result of many years' work by F. T Bacon. This cell requires pure hydrogen and oxygen gases for successful operation and uses potassium hydroxide solution as the electrolyte; the electrodes are made of porous sintered nickel and the main cell parts are of nickel-plated steel or pure nickel. Oxygen molecules on the positive electrode combine with water to form negatively charged hydroxyl ions which each remove an electron from the oxygen electrode. The hydroxyl ions migrate through the electrolyte to the negative electrode and there combine with hydrogen to form water, depositing an electron in the process.

To achieve high current densities high gas pressures were found to be desirable and present cells operate at between 300 and 600 lb per sq. in; an operating temperature of 200° C was selected, resulting in satisfactory reaction rates without corrosion which would occur at higher temperatures. To provide electrodes with a large active surface area and a very short diffusion path for the gases a double-porosity construction has been developed. A small pressure difference is set up across each electrode, so that the electrolyte is expelled from the large pores on the gas side, leaving a very thin layer of electrolyte on the surfaces; the gas is prevented by surface tension from bubbling through the smaller pores.

The use of gases other than pure hydrogen and pure oxygen is attractive because of the high cost of these gases with present production techniques. A number of experiments have been conducted, leading to the following conclusions:

(1) No fuel gas other than pure hydrogen is electro-chemically active on a nickel electrode at practicable temperatures.

(2) Hydrogen containing inert diluents, such as nitrogen or methane, and air instead of oxygen, can be used if provision is made in both cases for exhausting the residual gases.

(3) Carbon monoxide and carbon dioxide are soluble in potassium hydroxide solution; if these gases are present carbonation of the electrolyte results, leading to a serious loss in performance.

The largest battery so far built is a 40-cell unit with 10 in diameter electrodes, which has been successfully demonstrated as a practical source of power. The assembly produces 3·2 kW at 32 volt (0·8 volt per cell) with a maximum of 5 8 kW at 24 volt (0·6 volt per cell; specific power output 10·7 kW per cu. ft, based on cell internal volume). Fig. 3 shows the best performance obtained so far from a single 2¾ in diameter cell. A very accurate pressure balance has to be maintained between the two gases. This is achieved by keeping the oxygen pressure constant under all load conditions; an accurate differential pressure meter controls the admission of hydrogen by means of a servo-mechanism and power-operated valve. The water formed in the reaction is condensed out from the hydrogen-steam mixture leaving the cell, the process being controlled automatically by a second differential pressure meter which operates on the pressure difference between the hydrogen and the electrolyte. The unit is not self-starting and the initial heating is electrical. In operation, waste heat helps to maintain the working temperature; in very small sizes it may be impossible to keep the cell up to temperature and in large sizes cooling will be necessary.

Bacon has stated that the high-pressure hydrogen-oxygen cell, in its present form, is now approaching commercial application as a completely automatic power source. Increases in specific power output of up to four times are anticipated.

Hydrogen-oxygen cells have been developed on a laboratory scale by other workers; the majority of these cells have operated at low temperature and atmospheric pressure and a number of electrode materials and electrolytes have been tried. Examples are porous carbon electrodes impregnated with a catalyst and a form of ion exchange membrane which replaces the liquid electrolyte.

Redox Cell

In the redox system intermediate charge carriers pass through the cell itself and are regenerated externally by reaction with the fuel and oxidant, the net reaction being equivalent to that of fuel combustion. The cell may be regarded as two half cells in each of which the only mechanism involved is the transfer of electrons between the atoms or ions of the electrolyte and the inert electrode. The electrolytes in contact with the anode and cathode of the cell are termed the anolyte and catholyte respectively. Two important advantages are claimed for the redox system to offset its complexities: many inorganic ions readily lose or gain electrons, so that it should be possible to choose reactions for each half cell that will proceed without much degradation of energy; the reactions with fuel

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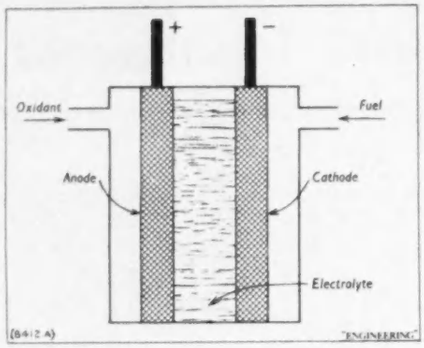


Fig. 1

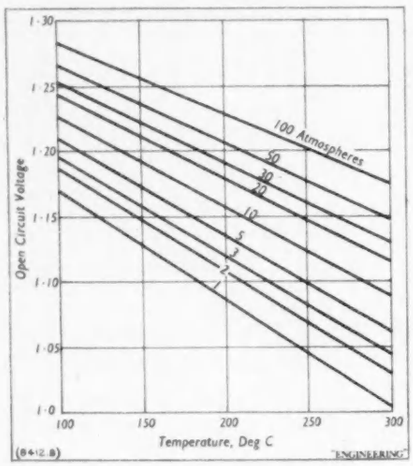


Fig. 2

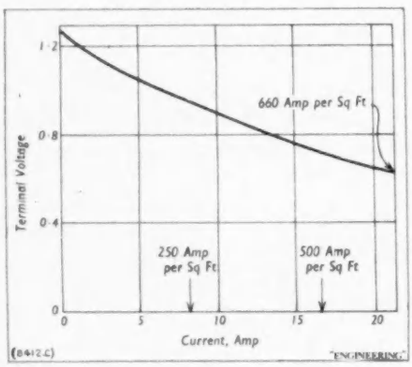


Fig. 3

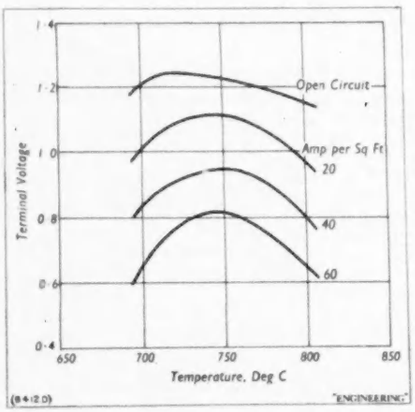


Fig. 4

Fig. 1 Basic arrangement of a fuel cell.

Fig. 2 Effect of temperature and pressure on the theoretical open circuit voltage of the hydrogen-oxygen cell: aqueous potassium hydroxide electrolyte, 27 per cent by weight.

Fig. 3 Best performance obtained so far from a single $2\frac{3}{4}$ in diameter Bacon hydrogen-oxygen cell. Operating temperature: 200° C; Operating pressure: 600 lb per sq. in. Aqueous potassium hydroxide electrolyte concentration, 80 to 90 per cent by weight.

Fig. 4 Effect of temperature on the performance of a typical high temperature fuel cell.

and air or oxygen can be carried out independently and each under optimum conditions.

Research on this type of cell has met with only moderate success. Suitable anolyte systems have been found which have a satisfactory performance within the cell and can be regenerated by reaction with atmospheric oxygen; catholyte systems perform fairly well within the cell but regeneration by reaction with coal or other fuels is difficult. The overall efficiency of the redox process is unlikely to be very high, even if some of the practical problems are solved, and very little work is now in progress.

High Temperature Cell

The difficulties associated with the low reactivity of carbon and gaseous fuels other than hydrogen led to experiments being conducted at high temperatures. Little success was achieved at temperatures below the boiling points of aqueous electrolyte solutions and the majority of high temperature cells have operated at above 500° C and used molten salt electrolytes. At these temperatures reaction rates are increased and the poisoning of electrode catalysts is reduced. Fig. 4 shows the effect of temperature on the performance of a typical high temperature cell.

This type of cell is being developed at the Sondes Place Research Institute, under the direction of Dr. H. H. Chambers. The work is aimed at producing a general-purpose cell which can operate on a wide range of gaseous and vaporised hydrocarbon fuels. Particular attention is being paid in the design of cells to the ultimate necessity of making the components by large-scale manufacturing techniques. A number of electrolytes have been studied, with the final adoption of alkali metal carbonates. The cell operating temperature is between about 500 and 800° C, the lower limit being due to the reduction of electrolyte conductivity and the upper limit to increasing corrosion rates. Corrosion has so far restricted continuous operating tests and a life of 10,000 hours is the immediate aim.

Operating experience has been gained with a variety of fuels; these have been classified into the following groups.

No polarisation: hydrogen, carbon monoxide, mixtures of hydrogen and carbon monoxide, and ethyl alcohol.

Little polarisation: propane, butane and kerosine.

Severe polarisation: methane and benzene.

Two basic forms of construction are being developed. In the first the molten electrolyte is contained by double-porosity electrodes similar to the type developed by Bacon; in the second the electrolyte is contained in a ceramic matrix (magnesia with about 50 per cent porosity). The second type has received more attention than the first, having obvious constructional advantages, since the double-porosity electrodes usually require a rigid backing plate. The specific output, excluding auxiliaries, of a cell assembly giving a few kilowatts would be about 2 kW per cu. ft at 0·7 volt per cell; through foreseeable improvements an output of 10 kW per cu. ft should be achieved.

Other Types

Of other types of fuel cell which have been studied the most interesting are a cell in which the carbon electrode is itself consumed as the fuel, a cell which functions on an alkali metal amalgam and oxygen and cells which operate on liquid reactants.

The first has so far achieved a very low performance. The amalgam cell, operating at 45° C and 1 atmosphere pressure with a concentration by weight of 0·5 per cent sodium in mercury, gives an open circuit voltage of 1·9 and a specific power of about 1·5 kW per cu. ft at 1·4 volt and 3 kW per cu. ft at 0·9 volt. One liquid system which has been proposed is based on the conversion to an electrolyte of fuel oil by emulsification with a soap. Another type of cell utilises hydrazine and hydrogen peroxide as the reactants. The main disadvantage of most liquid system is the high cost of the fuel substance compared with the fossil fuels.

APPLICATIONS

For economic large-scale electrical power generation, the fossil fuels must either be used in their naturally-occurring form or in a form obtained by a relatively simple industrial process.

The performance of the Bacon cell, in terms of specific power output and operating life, is very much superior to that of other fuel cells. However, the cell will only operate satisfactorily on pure hydrogen, and the cost of preparation from fossil fuels renders it unlikely that at present any type of hydrogen cell would be economic for large-scale generation. The main application of this type of cell is probably as a device for the storage of energy.

Cells of this type are probably most suitable for traction purposes, in combination with a direct current motor. The cell is able to take large overloads at reduced efficiency without damage, is silent and free from vibration in operation, has very few moving parts and the "exhaust" is only water. A very important advantage of fuel cell traction units over internal combustion engines is that part-load operation would be at a very high efficiency; overall operating costs could be very low. The large-scale use for vehicles and other mobile units would depend on the economics of energy storage by the production of hydrogen and oxygen and the development of suitable methods of storing these gases, either in liquid form or as a compressed gas at a very low temperature. In certain circumstances, for example, as a submarine power unit or space system auxiliary, economic considerations could be outweighed by technical and operational advantages.

Electrolytic processes are undergoing evolution and in particular, a high pressure water electrolyser developed in Switzerland and manfactured in Germany produces pure hydrogen and oxygen at pressures of up to 600 lb per sq. in. The efficiency is 80 to 85 per cent, and the cost of the products much less than with present electrolysers. Possibly the use of nuclear reactor plant with high pressure water electrolysers to achieve high load factor operation could be justified economically. The hydrogen and oxygen could be used for other purposes, such as traction, or to store energy for subsequent release at peak demand periods. In the latter case, it is unlikely that the overall efficiency of the electrolyser-fuel cell combination could initially be greater than 50 per cent, even if it proves practicable for a single unit to act as both electrolyser and fuel cell.

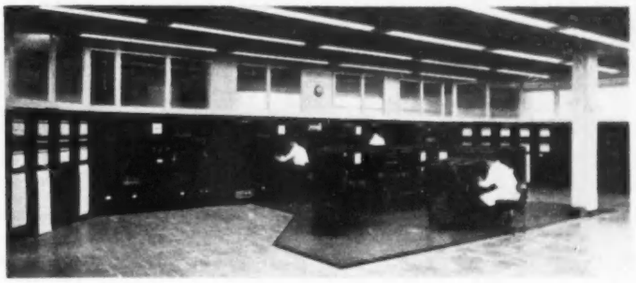
Although the redox cell in principle offers some prospect for the direct utilisation of coal, on present performance it does not warrant consideration as a competitor to conventional plant. The two regenerators will each occupy several times the bulk of the cell itself, and losses in the regenerative processes are likely to be high.

The high temperature gas cell is probably the only type that could be used in conjunction with fossil fuels for large-scale generation. Fuel gases (hydrogen, carbon monoxide and hydrocarbons) would be produced by coal or oil gasification processes. However, plant to manufacture suitable fuels would probably be

Comprehensive Nuclear Reactor Simulator

The control and transient response of power reactor systems require careful investigation at the design stage. An important contribution to the design of several nuclear reactors, including those for the Bradwell and Latina stations, has been made by the reactor simulator installed in C. A. Parsons Nuclear Research Centre, Newcastle upon Tyne. This machine is a large analogue computer having some unusual features to enhance its performance on the particular problems involved in reactor design and operational studies.

The reactor simulator (illustrated) is capable of measuring and operating on analogue variables to an overall accuracy of 1 per cent for large-scale problems while integrations with time constants ranging from milliseconds to hours in duration are quite practicable. This permits the simulator to operate in real time on the solution of most reactor problems, and hence to allow the testing of actual component items for instrumentation and control systems.



The reactor simulator, built by C. A. Parsons at their Nuclear Research Centre, Newcastle upon Tyne, is capable of measuring and operating on analogue variables to an overall accuracy of one per cent.

In contrast to most commercial "general purpose" analogue computers, the simulator contains a number of special devices for generating the many non-linear functions needed in siumulating a complete nuclear station. These include fractional powers of coolant mass flow and heat radiation terms involved in heat transfer equations; square, sin, cos and tan functions necessary for spatial temperature distribution in the reactor core and blower speed variations; exponential functions concerned with reactor kinetics and fission product power decay; and step, ramp and purely empirical functions used to simulate safety relays and to impose arbitrary input changes. These special devices effect considerable economy in computing amplifiers. The simulator is nevertheless a large installation its size having been dictated by the necessity for solving both the reactor kinetics (neutron equations) and the thermodynamics of reactors sub-divided into six separate zones. For simpler treatments the machine can be used as three separate simulators. Although specially designed to meet the needs of the C. A. Parsons' nuclear reactor design group the computer can readily be programmed for the study of the dynamic behaviour of many engineering systems such, for example, as boilers, turbines and the overall automatic control of plant.

Reactor start-up characteristics have been investigated in relation to initial neutron power level, control rod drive rates, xenon poisoning, and other factors. Very exhaustive safety programmes have been run on the simulator to determine temperature excursions due to uncontrolled reactivity transients, loss of coolant and other failure conditions, and measures to limit these hazards have been assessed. The effect of moderator temperature coefficient changes during the life of a reactor on its inherent stability has been studied, in relation to control requirements, while the simulator has been used in developing control instrumentation, firstly to determine the step response of the reactor as a basis for design, and later to check the performance of the complete auto-control equipment. Actual safety instrumentation for the Bradwell station has been tested. At present extensive studies are in progress concerning the performance of boilers similar in design to those installed in the Bradwell station.

Corrosion in Oil Fired Boilers

Tests have been made on a series of heat resisting alloys which were exposed to ash deposition in the superheater zones of oil fired boilers. These tests, which were instigated and carried out by the Corrosion I Committee of the Council of British Manufacturers of Petroleum Equipment, are reported in the official journal of the Council, *British Petroleum Equipment News*, Nos. 4 and 5, vol. 7.

The alloys tested included a ferritic 26 per cent chromium steel, and nickel-chromium or nickel-chromium-iron alloys containing 17·1 to 24·3 per cent chromium and 10·9 to 77·8 per cent nickel. Specimens of each alloy were placed at specific locations in land boilers at Bankside and Haifa (Palestine), and in the marine boilers of the SS Nestor. Gas temperatures were of the order 1,400 to 1,800° F.

After exposure, the appearance and weight of the specimens was recorded, and samples of scale and deposit were scraped off for examination by emission spectroscopy and X-ray diffraction. Small samples cut from the specimens were microscopically examined and in some cases semi-quantitative analysis by emission spectroscopy was checked by chemical analysis. The results of these analyses are given in full in the Committee's report, with special reference to the influence of the vanadium sodium (V:Na) ratio of the deposit.

The observations indicate that in land-based installations there is preferential deposition of the vanadium present in the oil. However, in the marine boiler the V:Na ratio of the deposit was less than that of the oil; this is believed to be due to the intake of sodium with the combustion air. The only alloy which showed good resistance to all deposits was the ferritic 26 per cent Cr steel (0·35 per cent C); this, however, has relatively poor stress-carrying capacity at high temperatures. Some resistance to high vanadium deposits (V:Na ratio greater than two-thirds) is found in alloys containing more than 60 per cent nickel. Austenitic steels with up to 20 per cent Ni are relatively resistant to attack by deposits of low vanadium and high sodium sulphate contents. Ni-Cr-Fe alloys of intermediate nickel content (30 to 60 per cent Ni) are severely attacked by deposits containing vanadium and sodium in all proportions, though this susceptibility was apparently reduced in two alloys (37·0 and 53·9 per cent Ni) with high carbon content and containing tungsten.

In the second stage of the report, results are given of laboratory tests carried out on the same series of alloys. The specimens were exposed in air, at temperatures of 1,200 to 1,560° F, to attack by a synthetic oil-ash, and to mixtures of sodium sulphate and vanadium pentoxide. Some tests involved single, and others repeated deposition of the corrosive medium on the specimen. In general, the results showed good correlation with those of the field trials.

Concluding **Fuel Cells**

much larger than the cell itself; the cost of the fuel gases could more than offset the increase in thermal efficiency obtained. If the efficiency of a fuel cell installation were considerably higher than in present day stations, the cooling water requirements would be much reduced and in some circumstances this would represent a large saving in space and cost.

When large numbers of cells are connected n series it is likely that the d.c. output voltage will be restricted by electrical leakage to between 500 and 1,000 volt. The economic transmission of power will require inversion and transformation to high-voltage a.c. which adds to the capital cost of the plant. Large-scale power from fuel cells may therefore find application in electrochemical and electrometallurgical processes, such as copper refining and the production of aluminium, which utilise fairly large quantities of d.c. at low voltage; powers of a few megawatts are typical. An interesting hybrid application is to allow substances to react in a fuel cell so as to yield very pure reaction products and sufficient electrical power for auxiliaries.

CONCLUSIONS

(1) For large-scale direct electrical power generation, the development of cells to operate on coke, coal or crude oil has so far been unsuccessful. More promising is the use of fuel gases derived from coal or oil gasification processes, in conjunction with a high temperature fuel cell.

(2) For large-scale electrical storage the medium temperature, high pressure hydrogen-oxygen cell may find application in conjunction with nuclear reactor plant and high pressure water electrolysers, enabling the reactor installation to operate at a high load factor, with subsequent release of the energy at peak demand periods. This type of cell is also attractive for traction purposes.

(3) Applications in the manufacture of industrial chemicals and as special-purpose power units may be attractive.

(4) In general, the development of fuel cells has reached a stage where a large-scale research effort is required if any of the potential advantages and applications are to be realised.

Acknowledgments

The author is indebted to the directors of C. A. Parsons and Company for permission to publish this article; and to Mr. F. T. Bacon, Marshall of Cambridge, Ltd., and Dr. H. H. Chambers, Sondes Place Research Institute, for supplying much of the information.

Hi-Fi: Discs and Pick-ups

By G. V. Buckley, A.M.I.E.E.

THE high fidelity reproduction of recorded music in the home may be said to have started with the possibilities offered by the post-war magnetic plastic-tape recording system which stimulated the revolutionary design of the micro-groove record. Such a 12 in record could give up to 30 minutes of continuous programme at a turntable speed of 33⅓ r.p.m., compared with 16 minutes from magnetic tape machines whose primary speed was then 30 in per sec, and with 4 to 5 minutes from the existing coarse groove 78 r.p.m. record. Further, the quality from the microgroove record was comparable with that from magnetic tape and much superior to that from the 78 r.p.m. record, as the effective high frequency response had been extended from about 6 kc/s to about 15 kc/s and the signal to noise ratio improved by 15 to 20 dB.

High fidelity reproduction from disc mostly originates from the 12 in disc which has been recorded with a variable pitch fine groove at a turntable speed of 33⅓ r.p.m., giving a playing time of up to about 30 minutes per side. These discs are cut for monophonic and stereophonic reproduction and are identically priced, about £2. The material used in their composition is relatively soft compared with the old 78 r.p.m. shellac records, and specially designed pick-ups must be used for their reproduction. It is essential in the design of these pick-ups that the vertical and horizontal components of the load offered by the stylus tip to the record groove be as small as possible so that the stylus tip follows the groove modulation precisely without deforming or leaving the groove.

If this load is kept sufficiently low that a playing weight of less than 3 grams is sufficient for accurate tracing of the grooves, then the stresses set up at the stylus tip will not exceed the elastic limit of the disc material and no damage will be done to the recording. It follows that the life of the disc and stylus will be lengthened considerably. Such a pick-up if designed for stereophonic working can be used on monophonic discs and if designed for monophonic working can be used on stereophonic discs to provide a monophonic output, provided that the bottom-of-the-groove and stylus tip radii are of the correct dimensions. It is not recommended, however, that older monophonic pick-ups be used on stereophonic discs because their excessive vertical loading will cause damage. There is also the danger of a stereophonic pick-up, which should have a stylus tip radius of 0·5 mils, producing a distorted output from a monophonic disc whose bottom-of-the-groove radius exceeds the recommended maximum value of 0·3 mils.

The grooves in these discs are cut with a 90° V, the sides sloping at 45° to the vertical. For stereophonic work one channel is represented by vertical and the other by lateral displacements. This arrangement offers about equal rumble in both channels, and lower in either than in a strictly vertical channel. It is also easy to balance the reproducing channels in the home.

In this system each channel will have both lateral and vertical components of the impressed modulation. Thus either could be reproduced by lateral or vertical pickups. The latter are rarely met in home reproducing systems but the former should be able to reproduce satisfactorily the lateral components of both channels, provided there is good vertical compliance. Thus the system is compatible with monophonic lateral recordings.

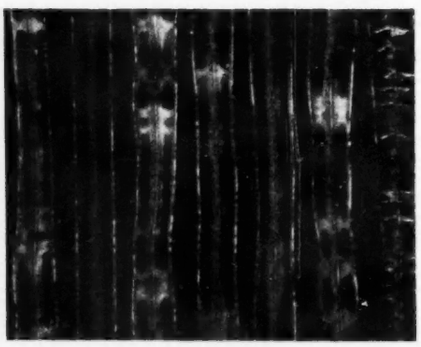
The pick-up arm is generally designed in conjunction with the head so as to ensure good tracking and to control arm resonances, particularly the main low frequency resonance which is a function of the arm and head and causes so much trouble and damage if it is not properly controlled.

There are a number of well designed pick-ups available today using variations of magnetic principles and the piezo-electric properties of crystals. The modern crystal pick-up incorporates into its design viscous damping in such a way that it is no longer an amplitude operated device but rather a combination of amplitude and velocity operation so that it requires very little electronic equalisation. The average price of a good pick-up is about £20.

A high grade turntable unit is generally known as a transcription turntable and has a minimum of rumble and speed variation. It is never fitted with the popular type of record-changer as the latter tends to increase the playing weight of the pick-up and is a source of damage to high grade records. Most of these turntables provide speeds of 78, 45 and 33⅓ r.p.m., and some the additional facilities of an extra speed of 16⅔ r.p.m., with a fine speed control so that the speed can be varied by a small percentage either side of the correct value. The average price of a transcription unit is about £25.

To maintain a high performance from disc it is necessary to take considerable care of the equipment and records. A comprehensive range of accessories is available for the proper care of both discs and pick-ups, and should be used.

The present trend in disc recording would appear to be indicated by the trickle of 16⅔ r.p.m. fine groove discs appearing on the market. Such a 12 in disc gives a playing time of 45 minutes per side which compares with 64 minutes per track of 1⅞ in per sec tape recording using extra long play tape wound on 3½ in cassettes. The quality of these discs at the moment does not warrant the term " high fidelity " but despite the inconvenience of four speeds on the turntable and the difficulties of reducing tracing distortion it would not be sensible to ignore this trend. With regard to stereophony it would appear that the industry and public are committed to the present system and any changes would be of the compatible type, such as an increase in the number of loudspeakers, their disposition, either within the room or in a single enclosure, and a re-distribution of information to them.



Photomicrograph of grooves in a stereophonic disc recording. Lateral components are shown by varying width and the vertical by the light and dark shading.

At the present time in this country, the reproduction of programme from tape records costs about twice as much as that from disc. This ratio would be reduced slightly if questions of length of life of the respective records and essential accessories were introduced. The comparison of quality is just as difficult a question but if first class systems were compared most probably the disc would produce the better quality mainly because it has a slightly better signal to noise ratio. However, the disc system is more difficult to maintain at its peak performance and it is also more difficult to produce top class programme discs in the first place.

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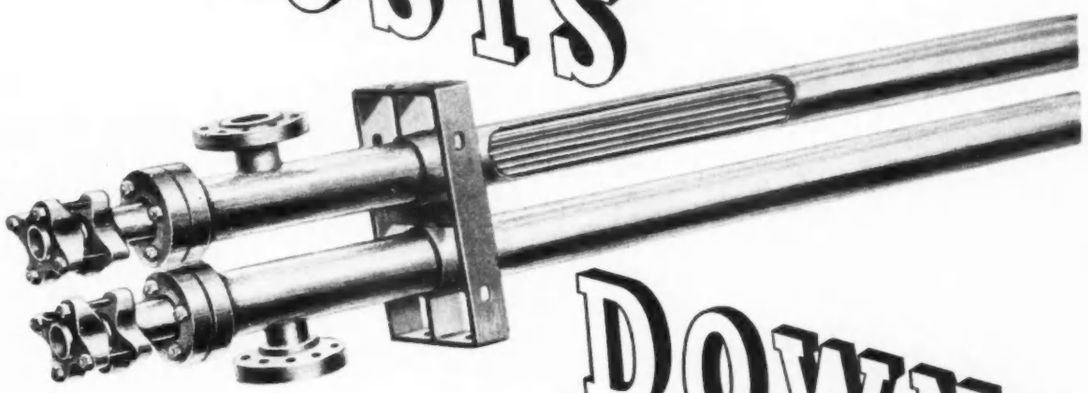

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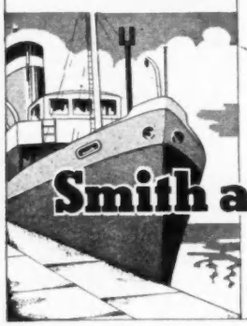

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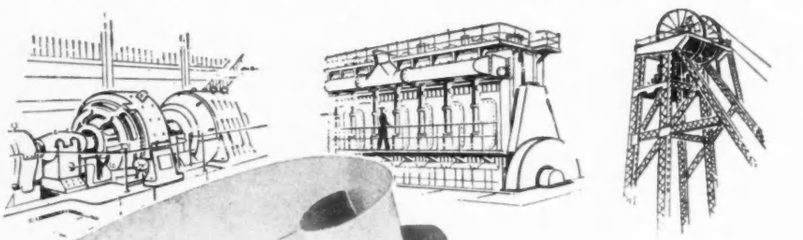

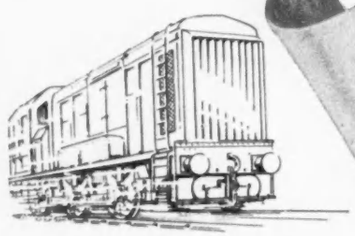

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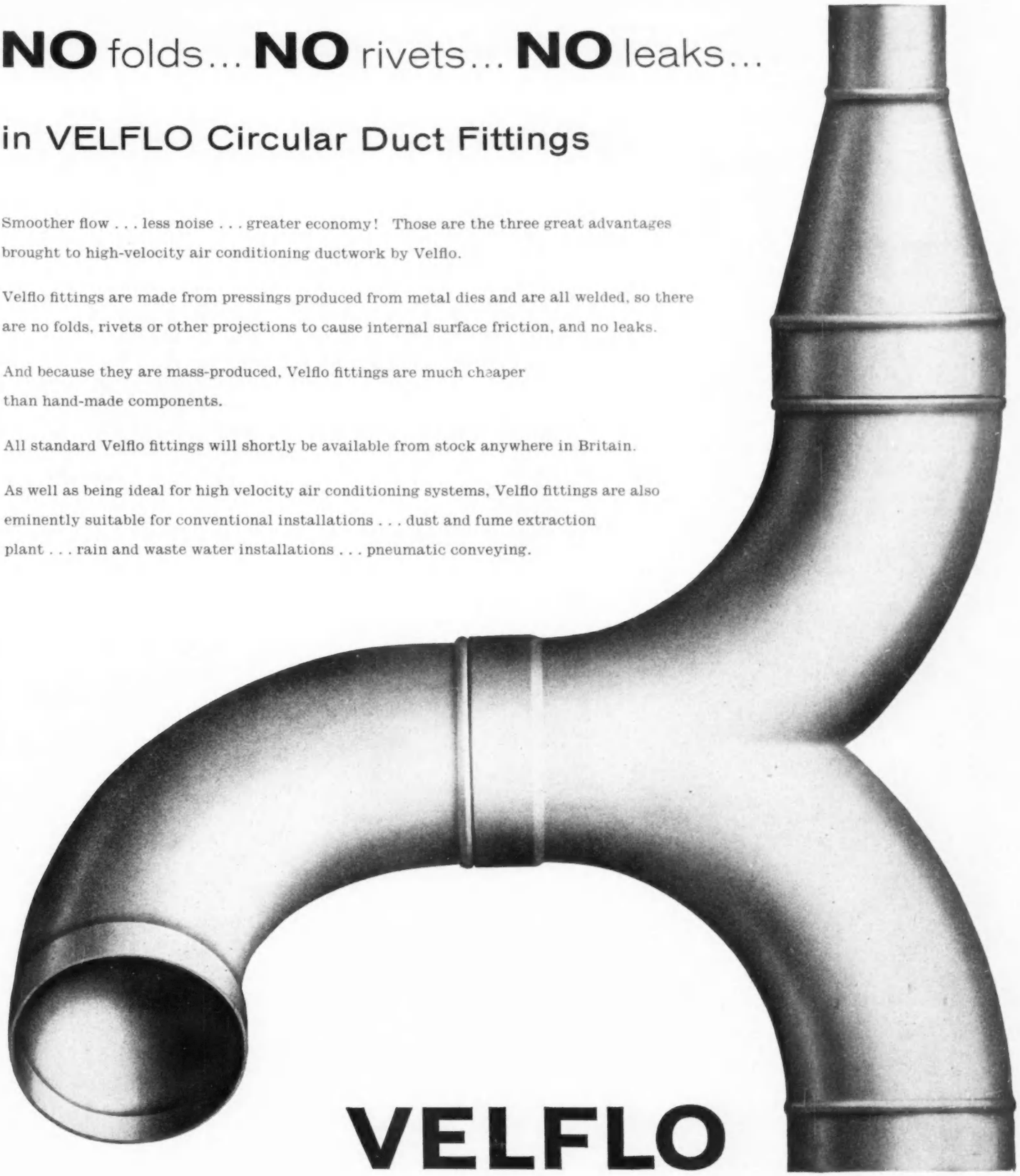

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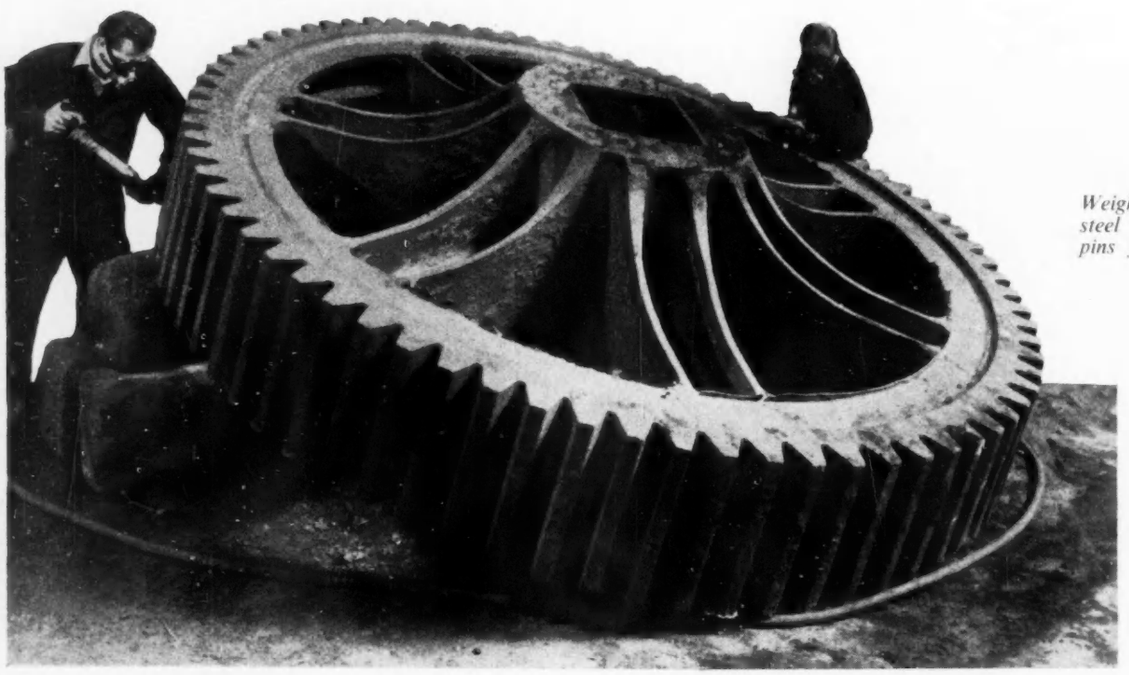

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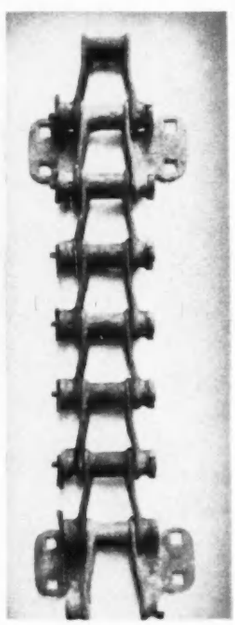

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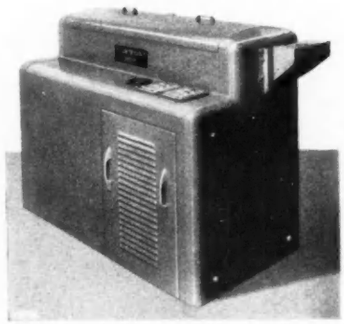

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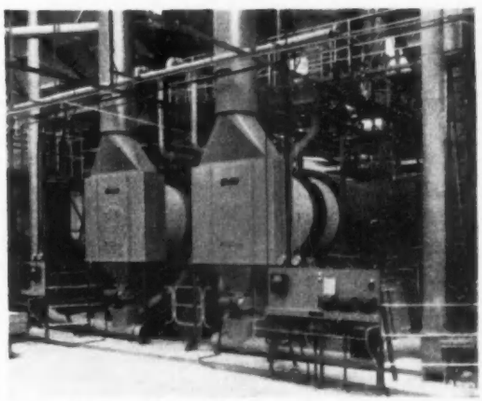

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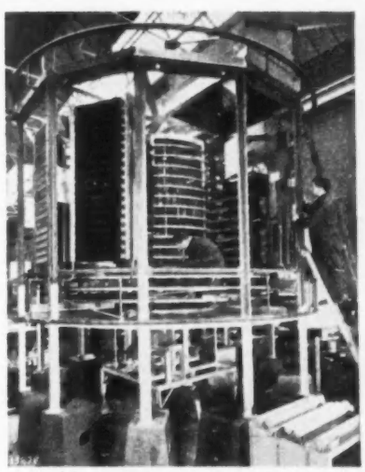

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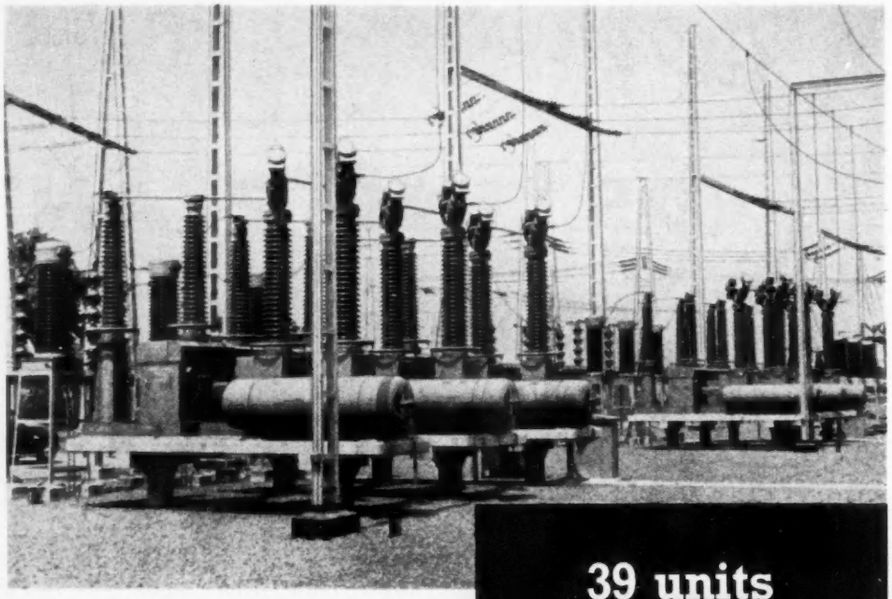

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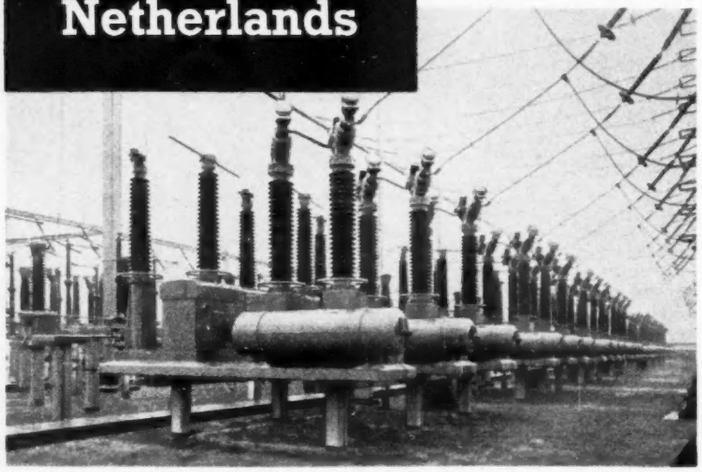

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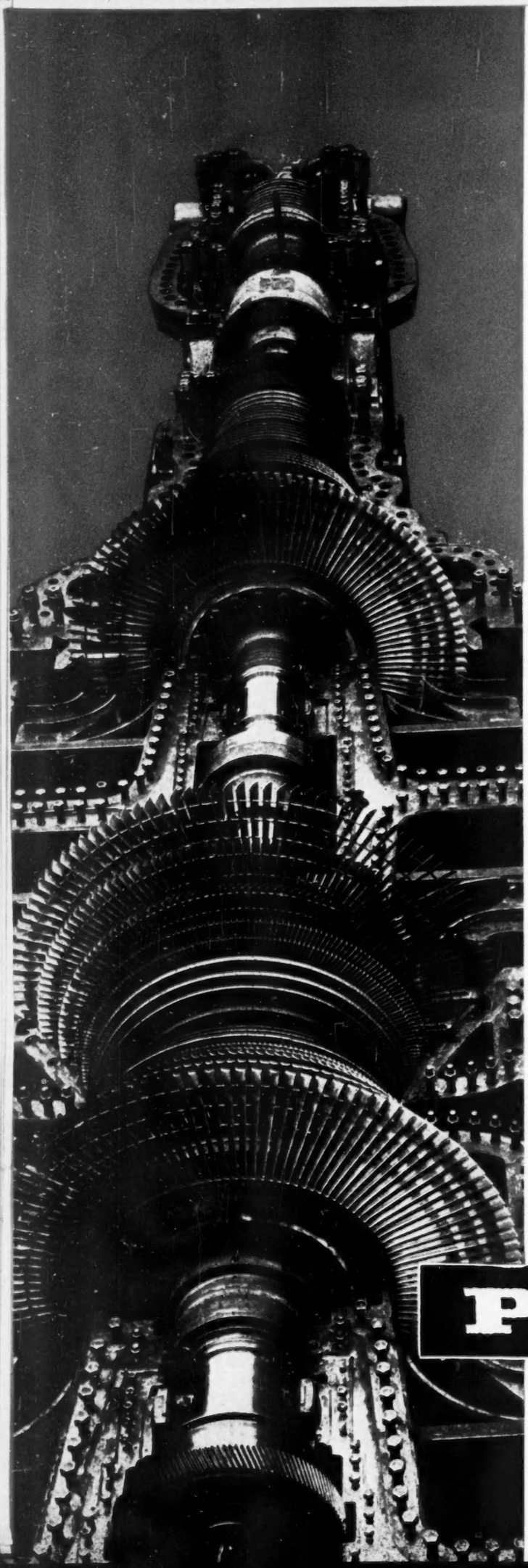

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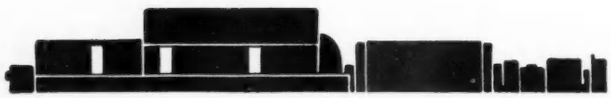

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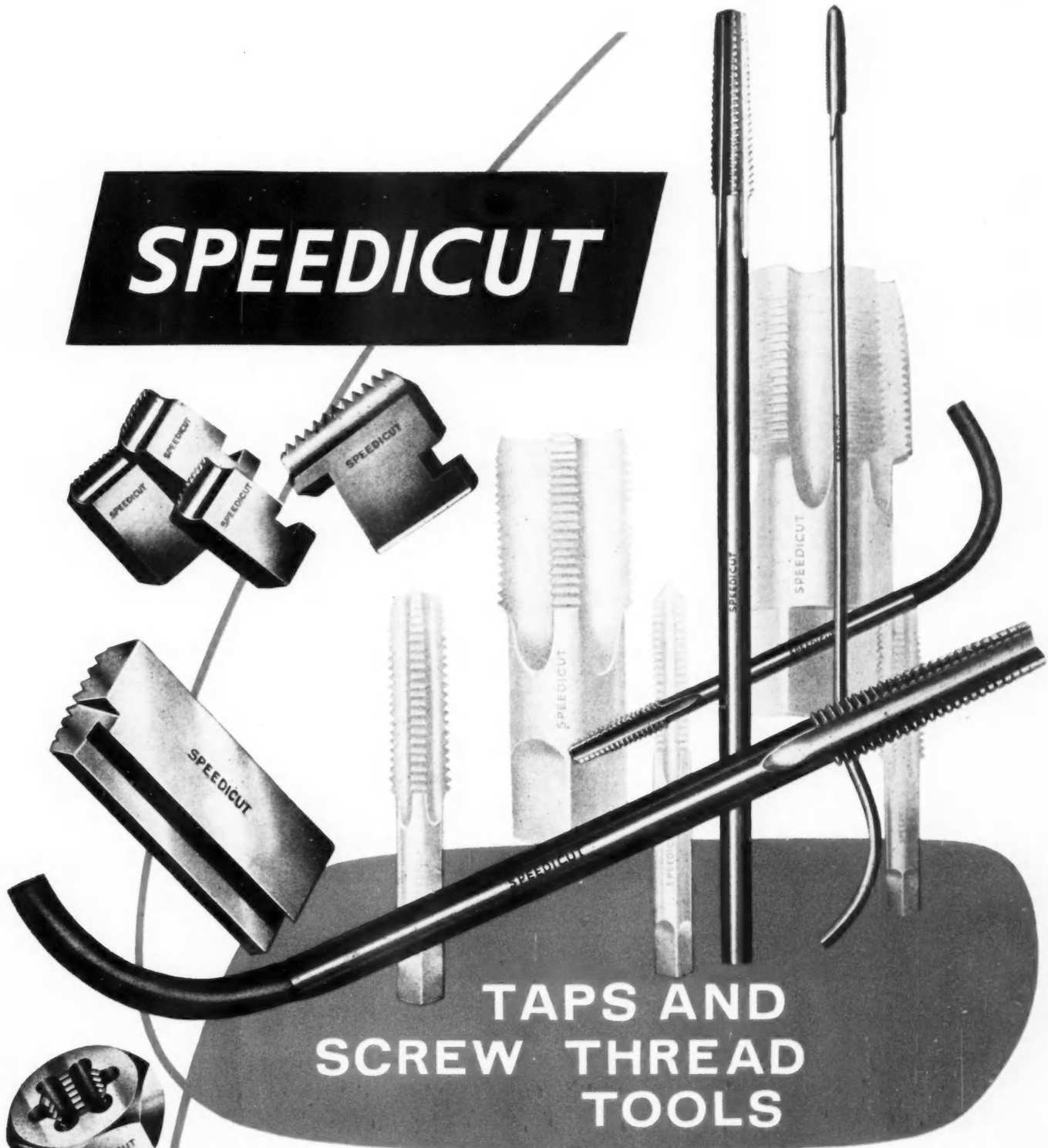

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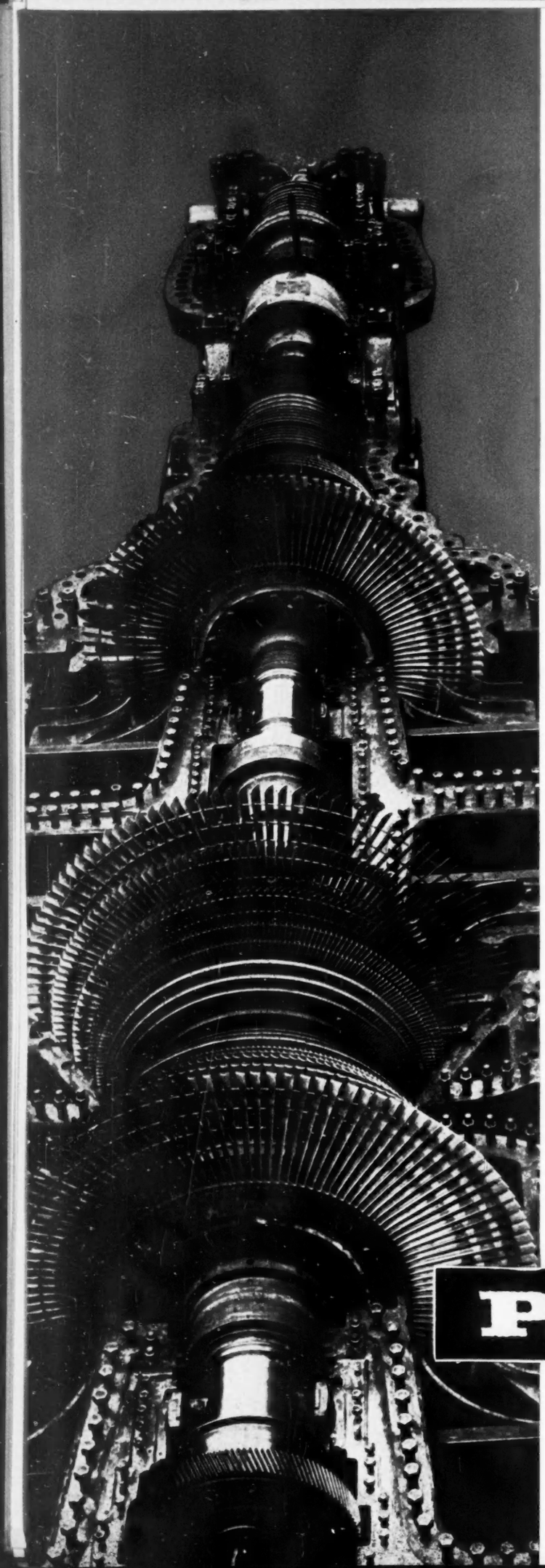

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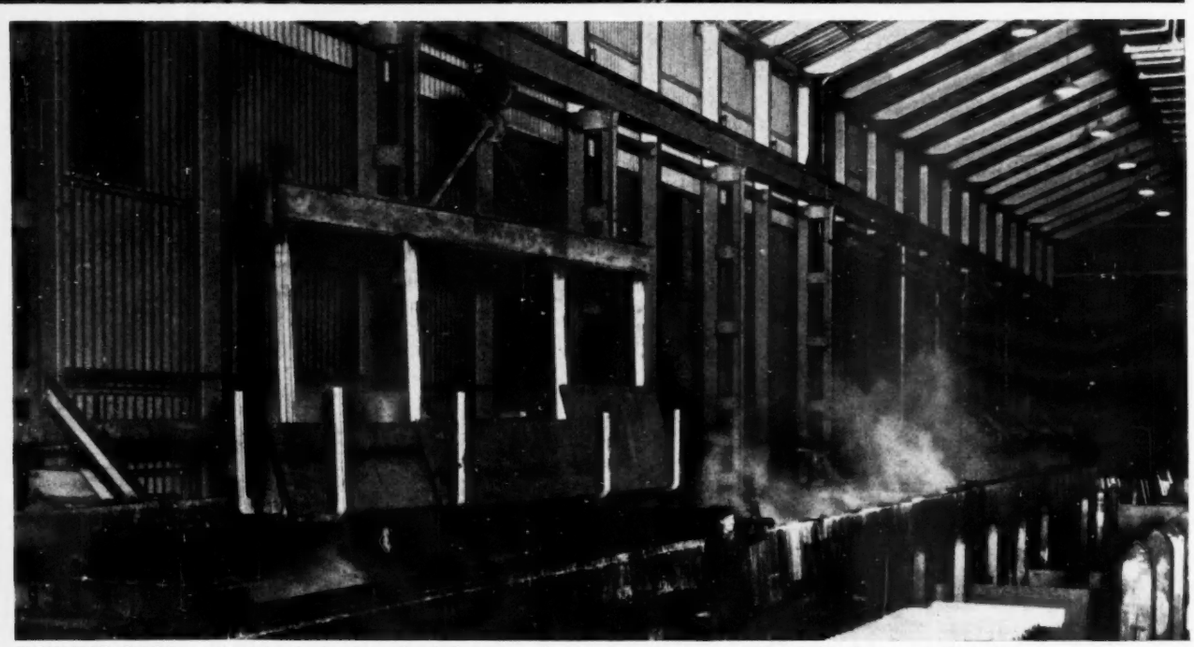

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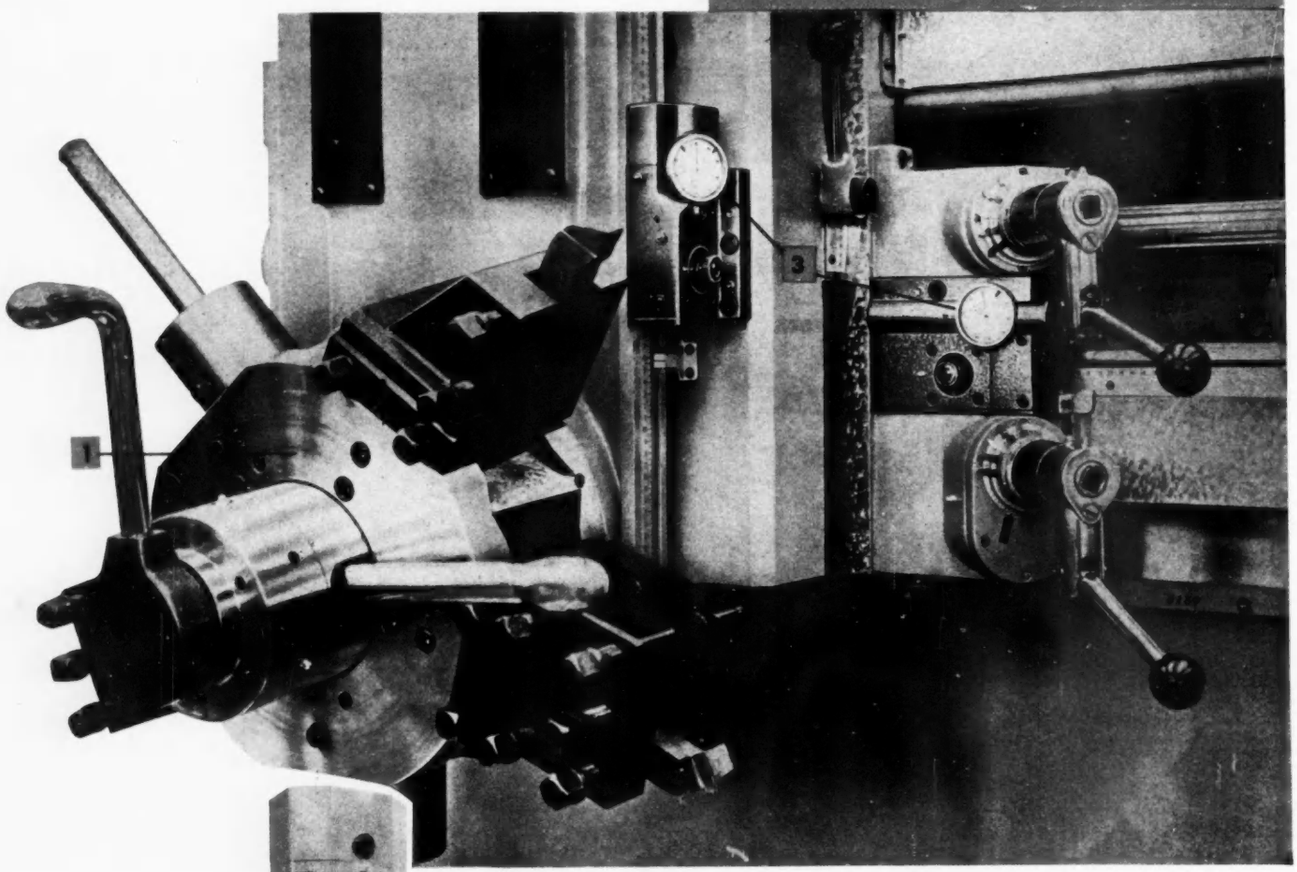

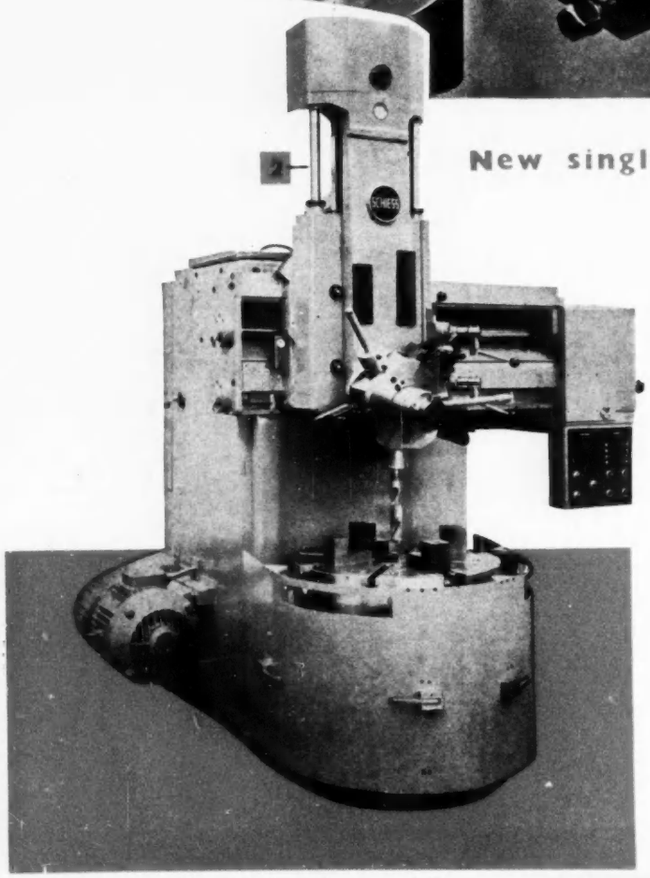

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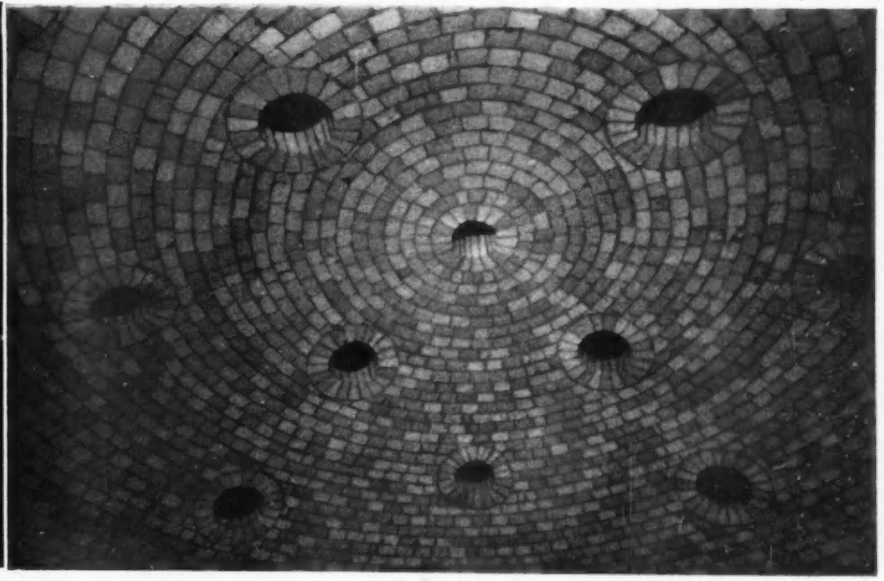

Five years ago we began rebuilding the round down-draught kilns of the Morgan Crucible Co. Ltd. at Battersea in MI.28—a hot-face insulating brick of low thermal capacity that was then comparatively new. The roof of one of these furnaces immediately after installation is shown in the first picture.

. . . (MI. 28 bricks) . . . and like it

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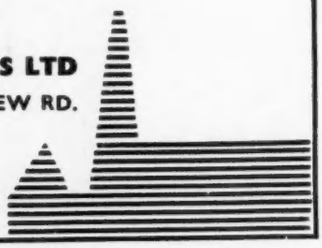

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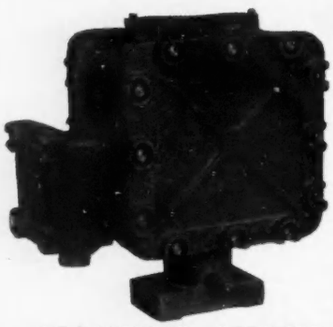

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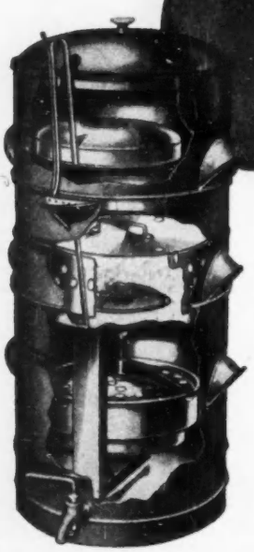

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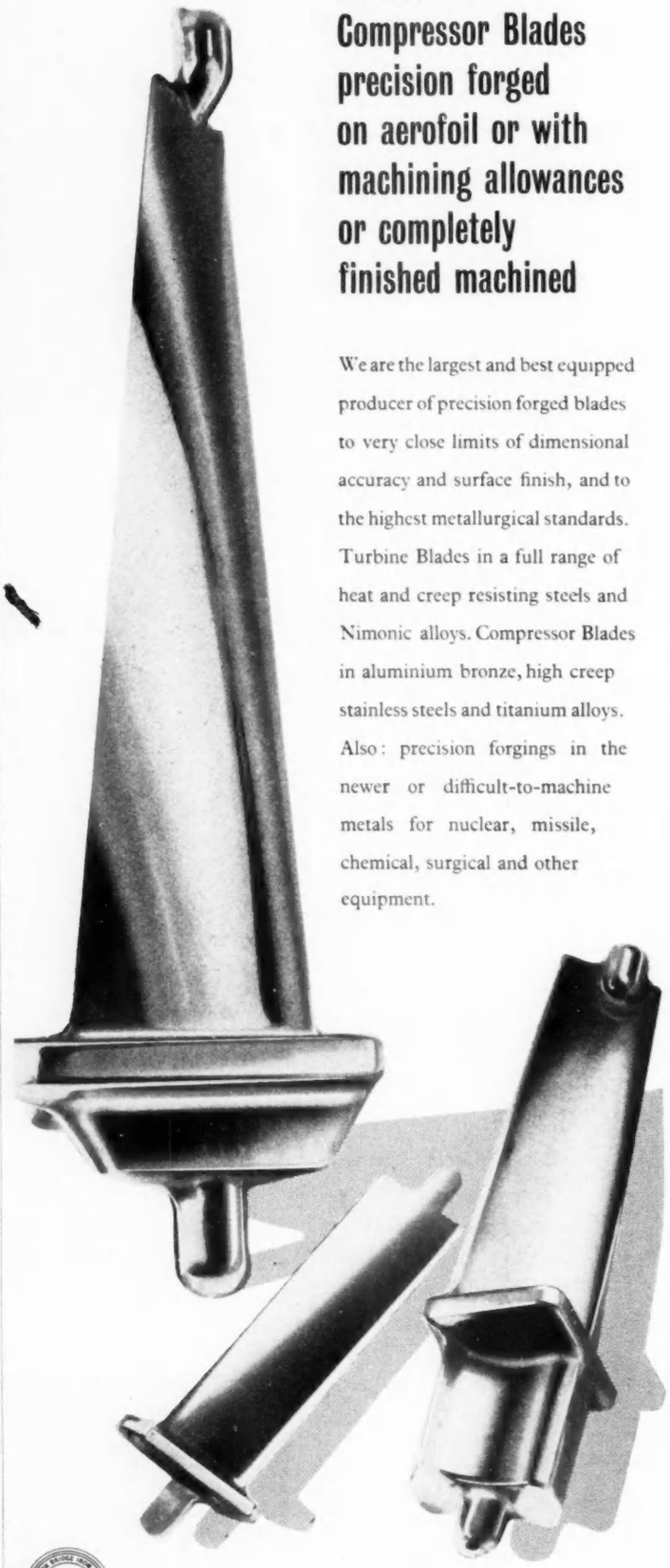

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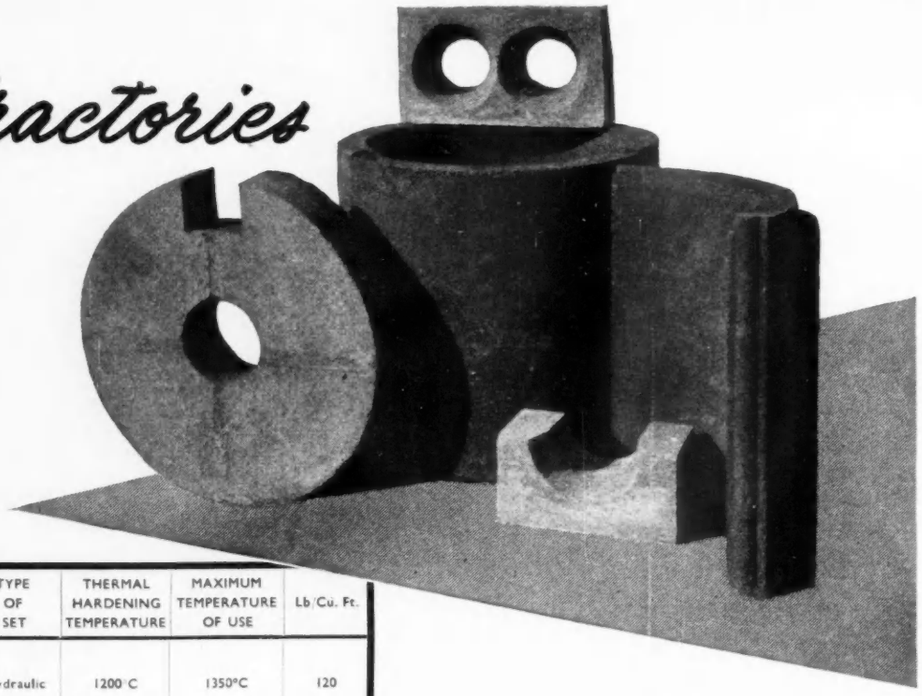

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No. 16	Dry	+ 1750°C	Hydraulic	1200°C	1600°C	160
No. 17	Dry	+ 1750°C	Hydraulic	1200°C	1700°C	160
No. 18	Dry	+ 1750°C	Hydraulic	1200°C	1800°C	160
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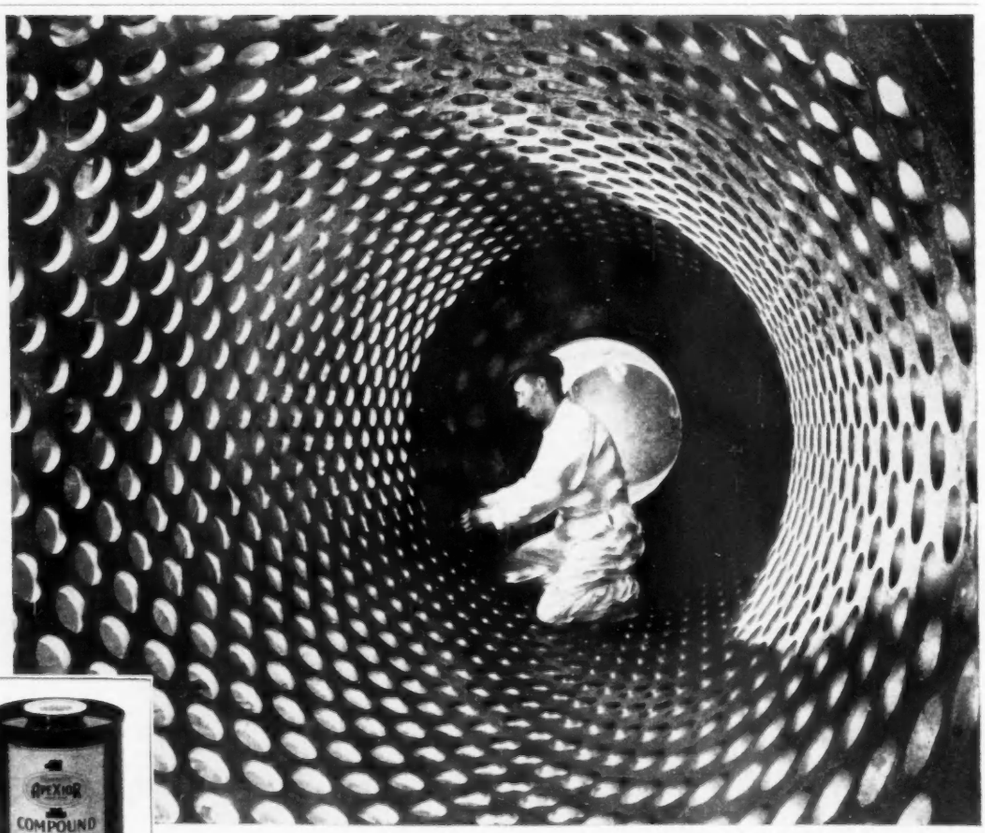

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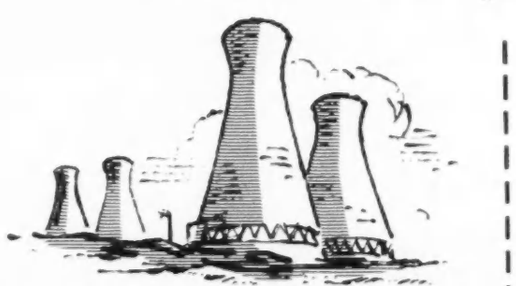

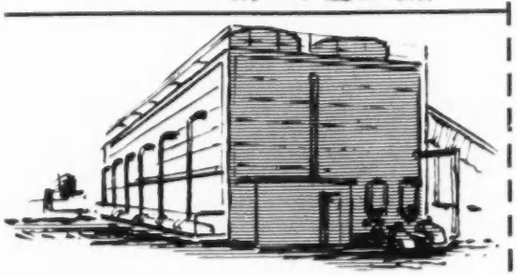

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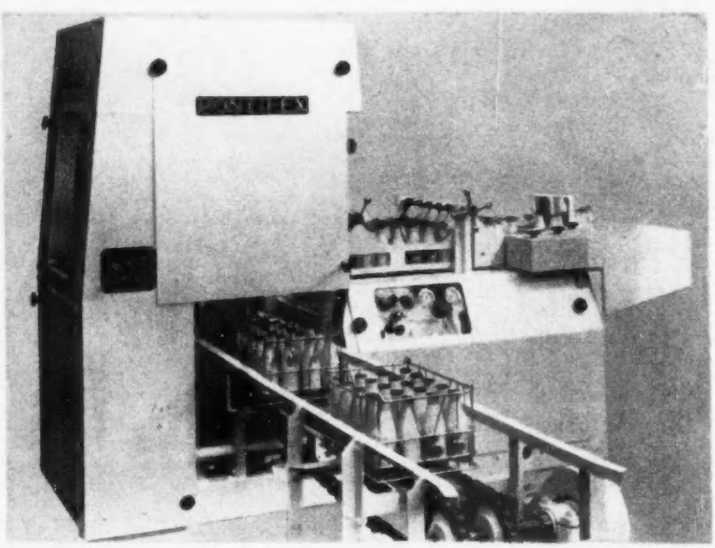

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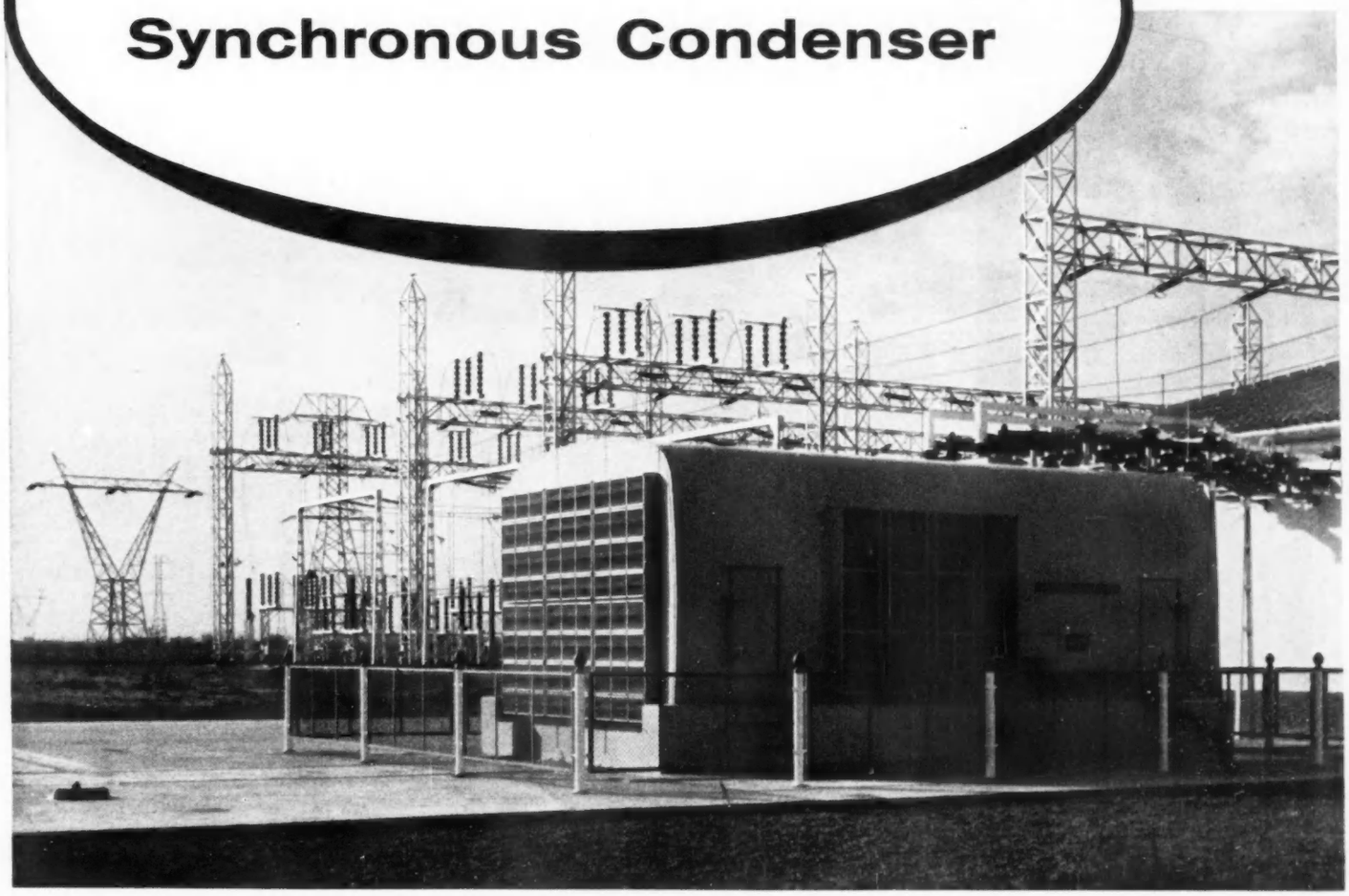

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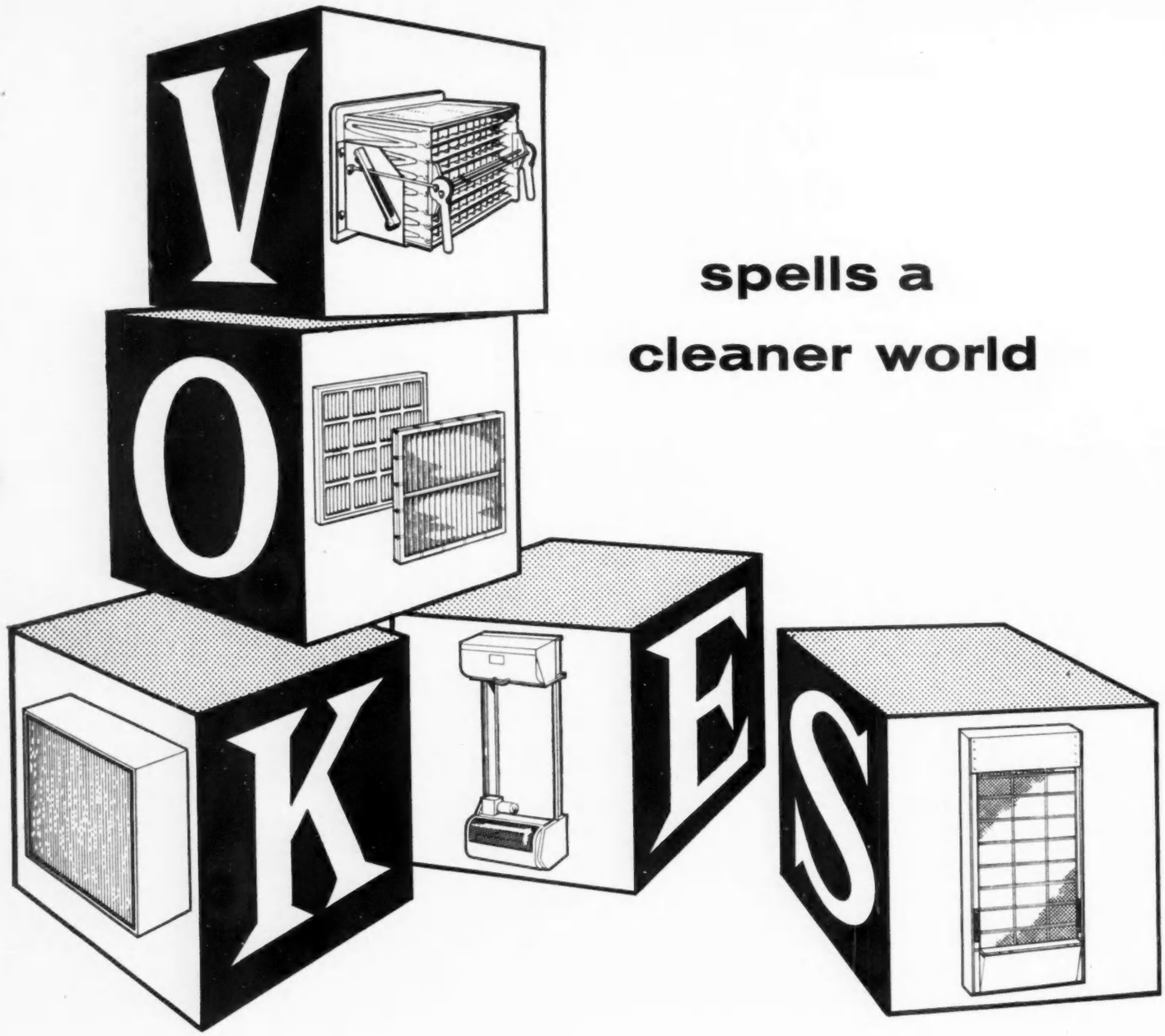

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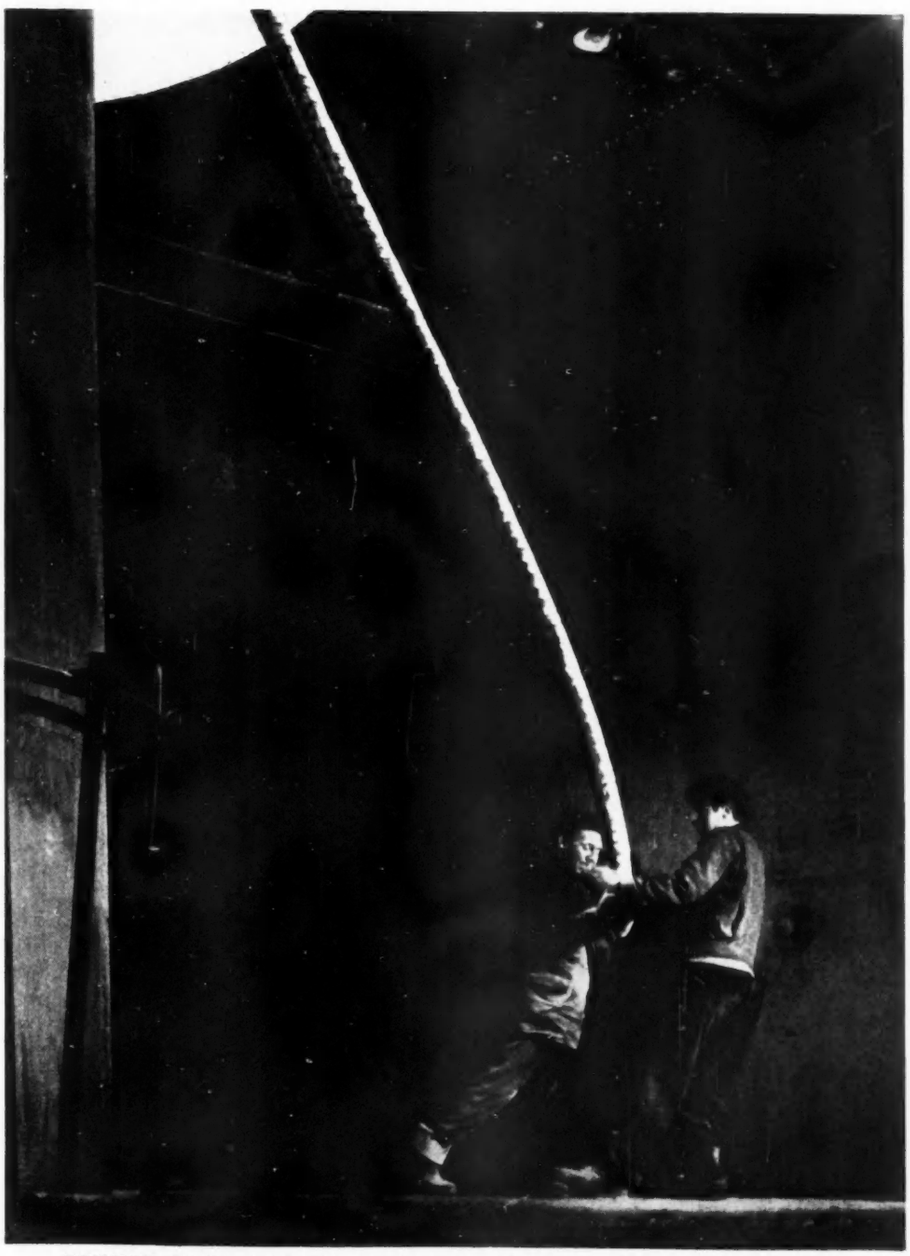

The Central Electricity Generating Board and Electricité de France have placed contracts for the manufacture and laying of the cross-Channel submarine power link.

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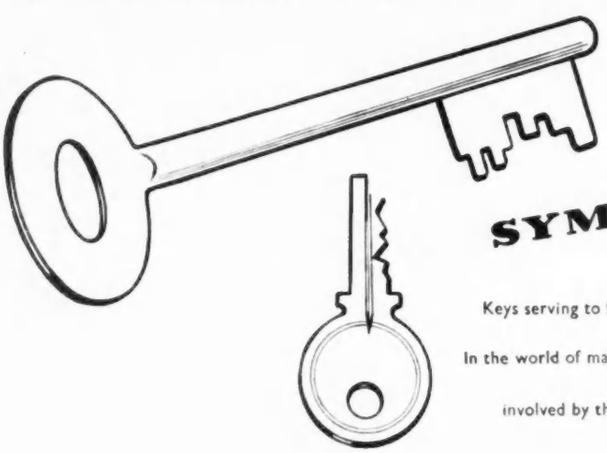

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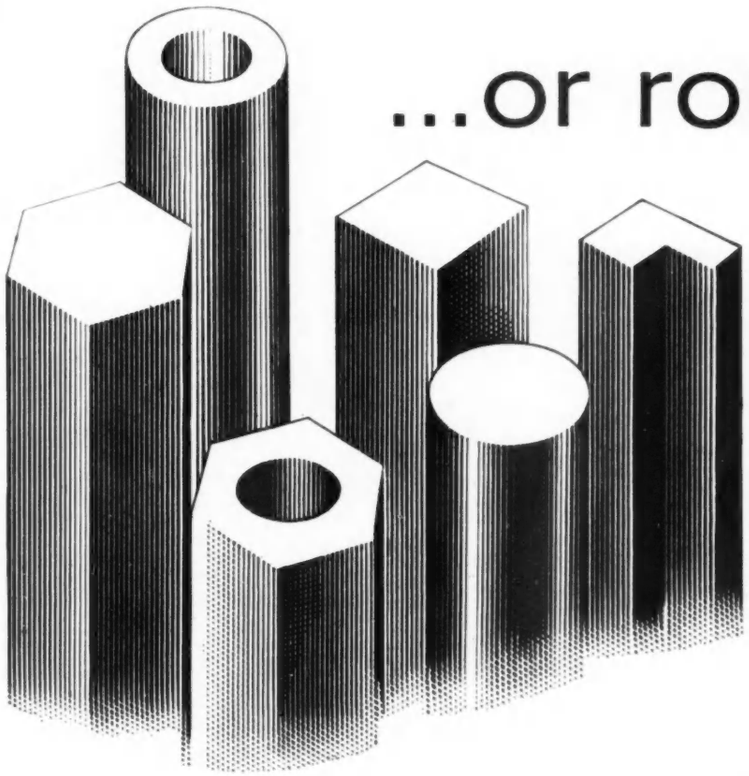

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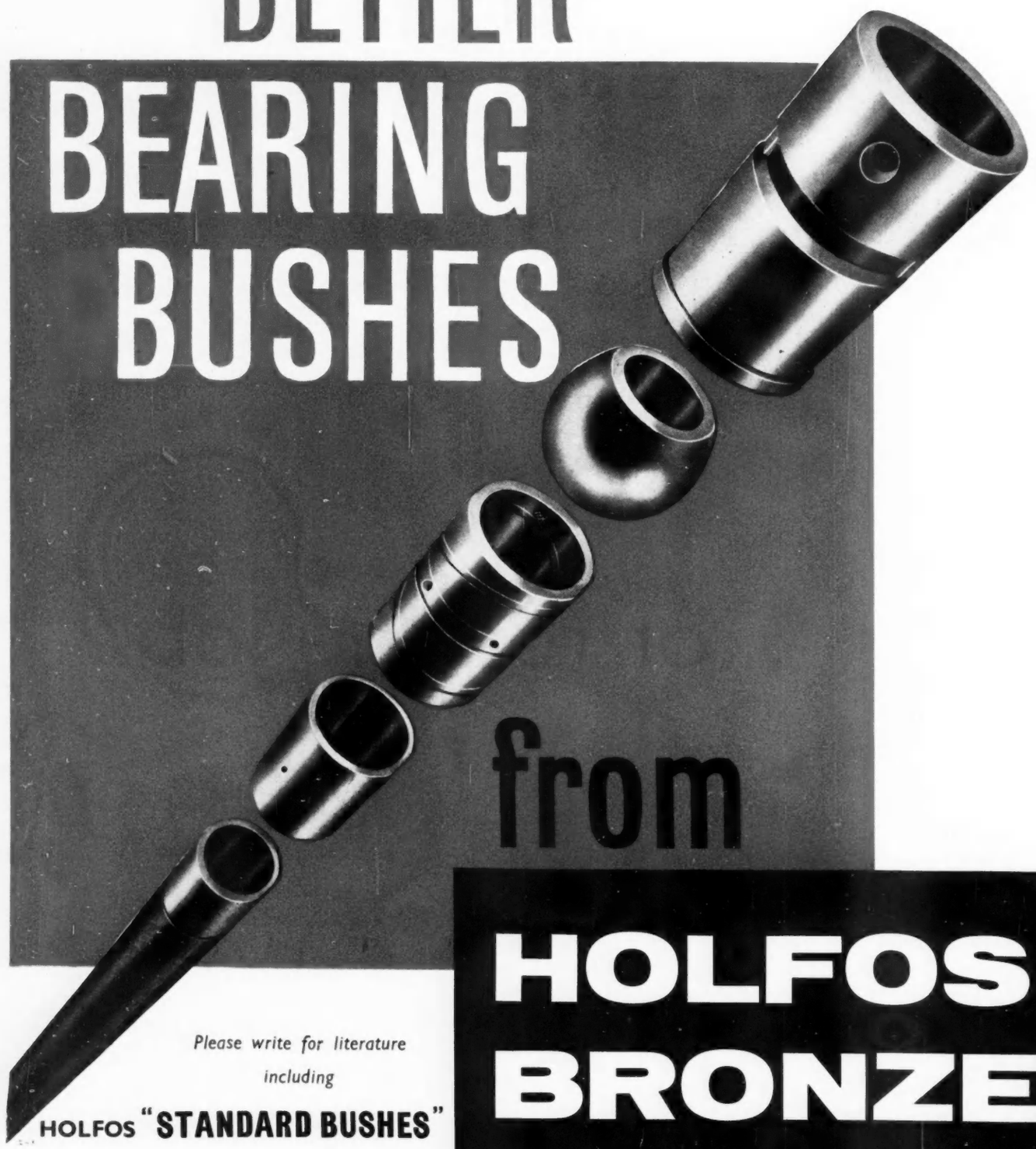

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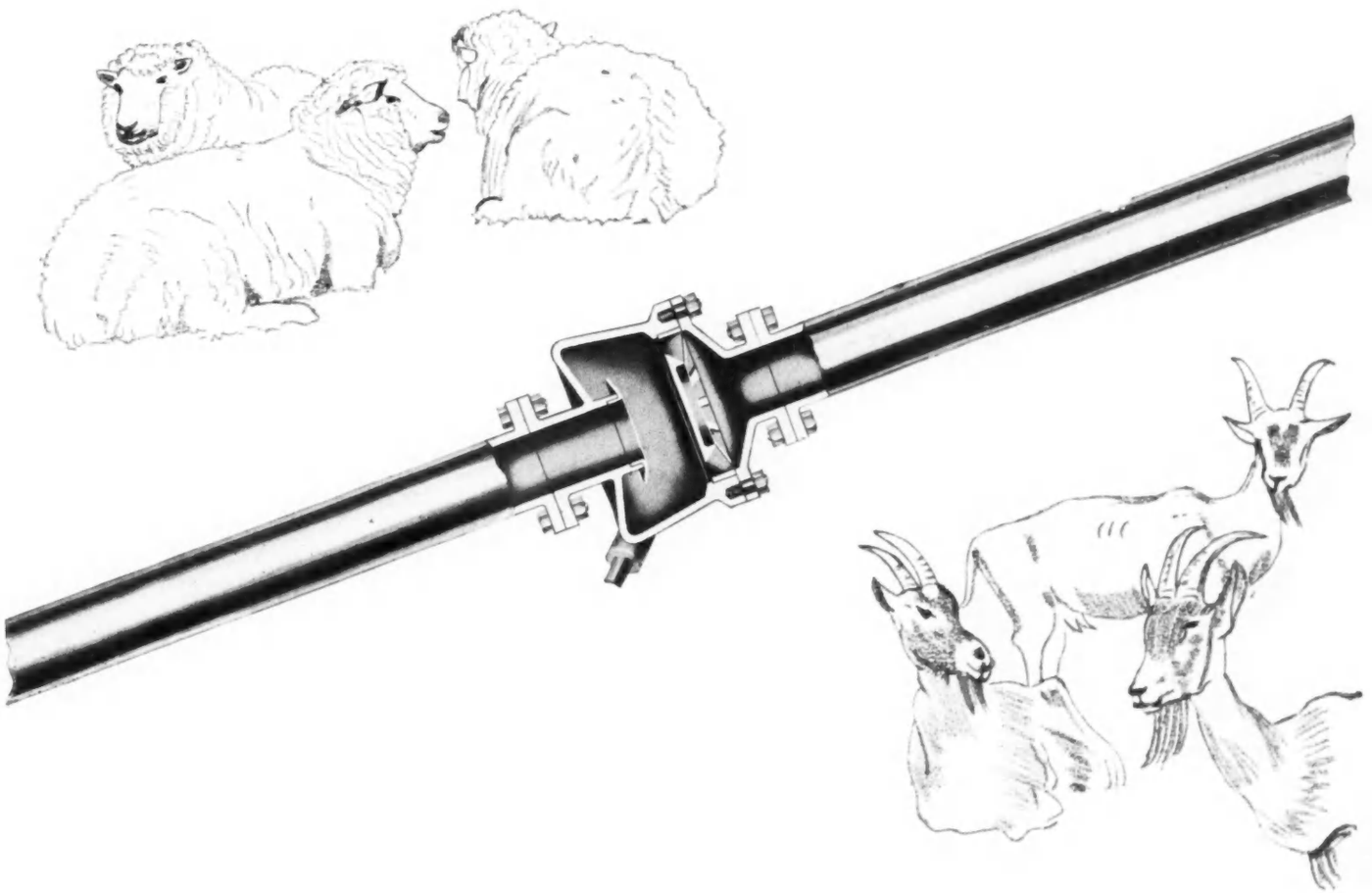

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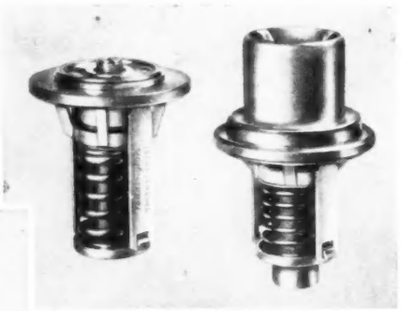

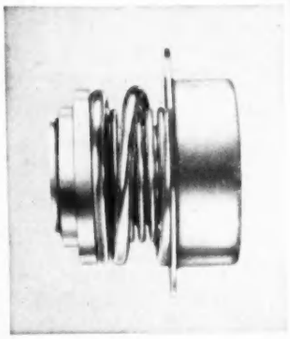

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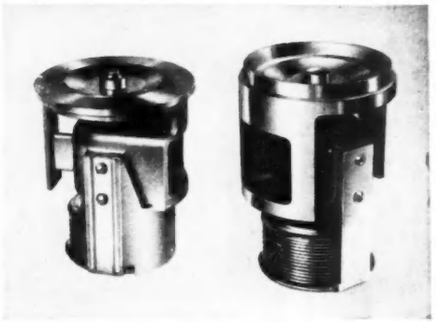

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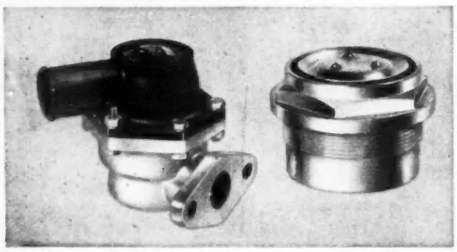

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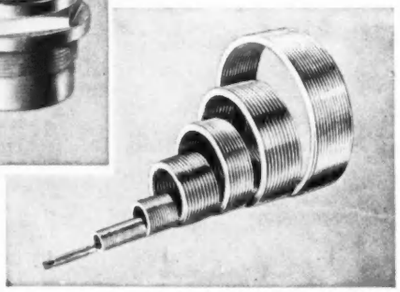

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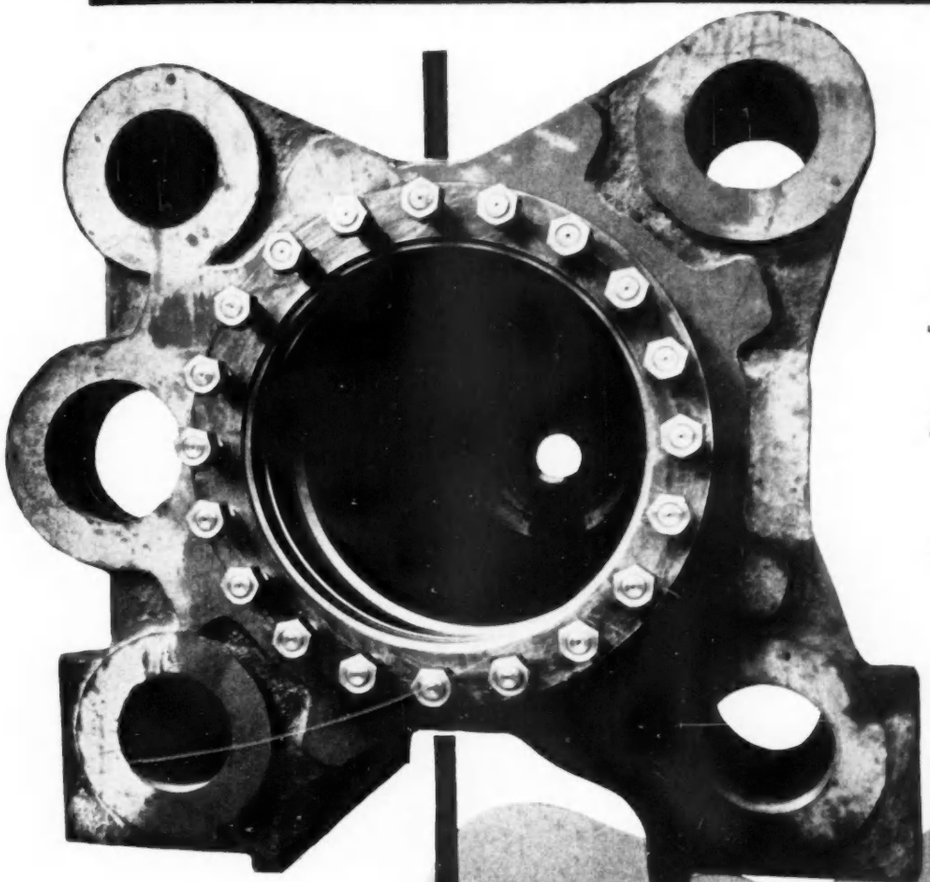

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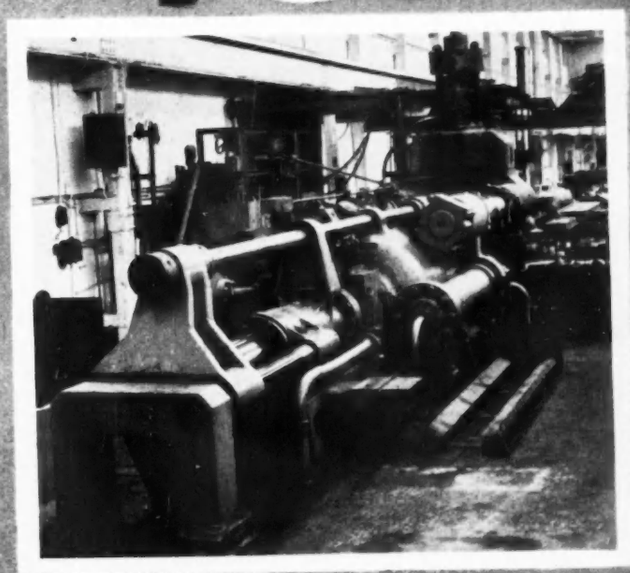

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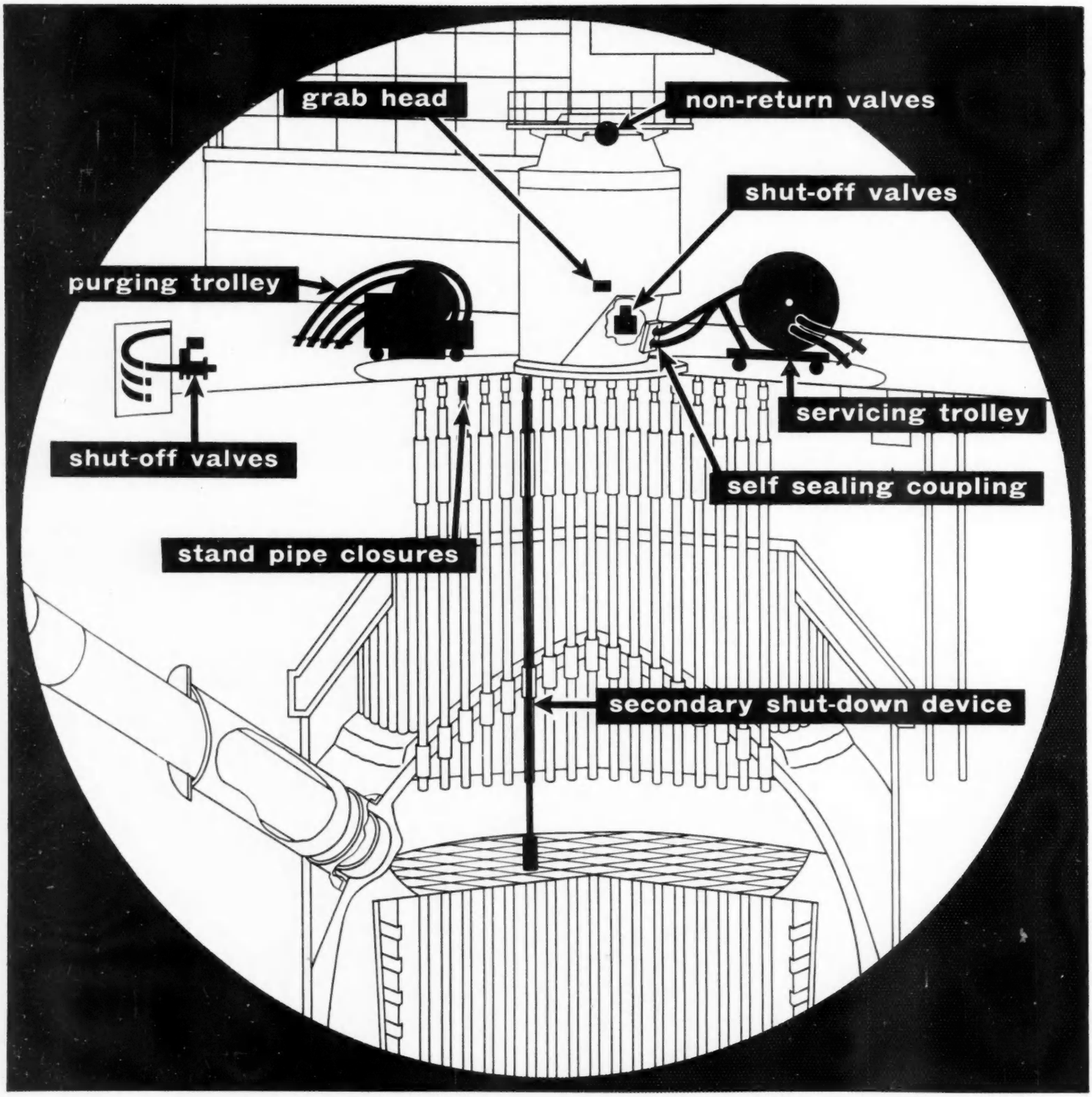

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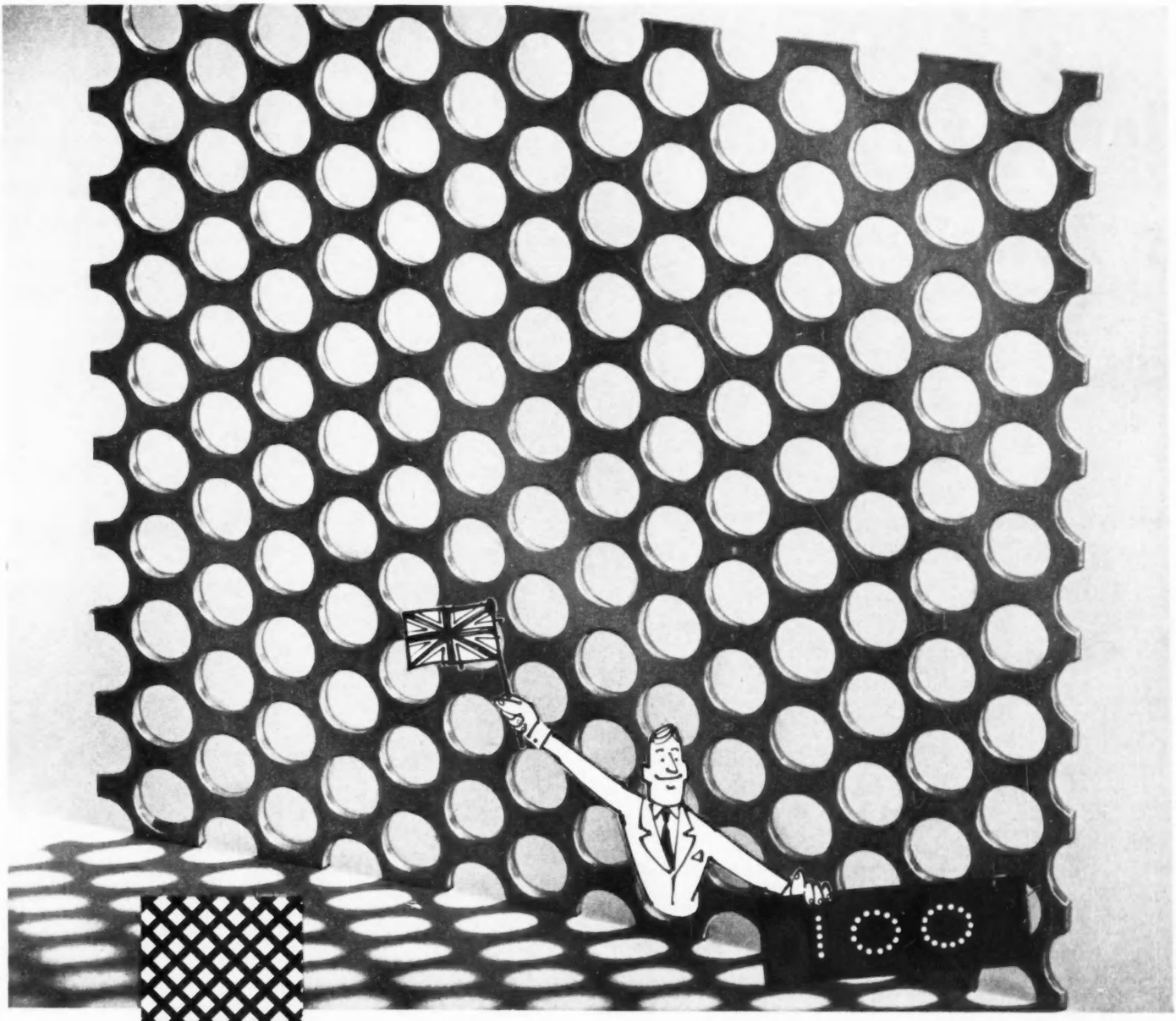

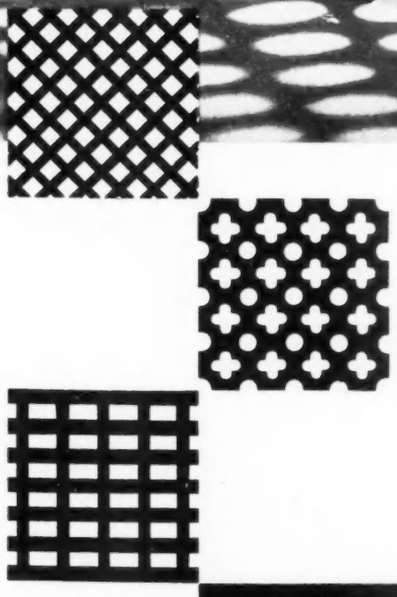

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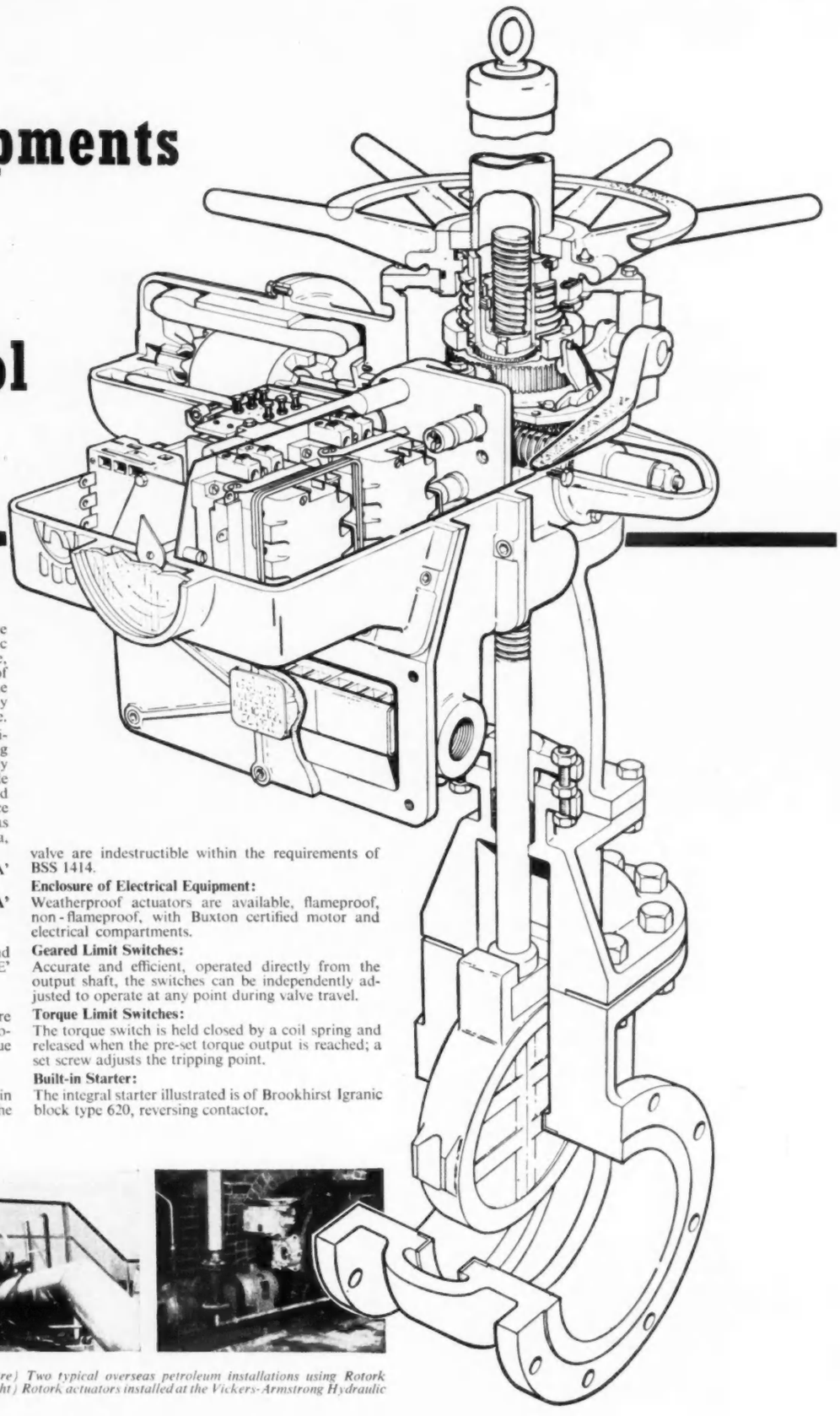
New developments in Rotork valve control



Valve manufacturers and users all over the world have helped Rotork develop their new series of electric actuators — the 'A' range. Such practical advice, coupled with Rotork's comprehensive experience of valve control, ensures that the 'A' range offers the most competent method available for automatically controlling any size or type of valve from any distance.

An entirely new manufacturing and selling organisation has been created to keep pace with the growing international demand for Rotork actuators. Highly competitive prices and good deliveries on a world-wide scale are assured by the overseas manufacturing and sales facilities now available in West Germany, France and Italy to augment U.K. production; as well as offices or agents in Holland, Switzerland, Australia, Canada and the Arabian Gulf.

A booklet covering every aspect of the Rotork 'A' range of actuators is available on request.

Outstanding features of the Top Handwheel 'A' Type Actuator illustrated are:

Motor:
Squirrel cage, Stator/rotor unit, half hour rated and built to BSS 2613. Available with class 'A', 'B' or 'E' insulation.

Input Shaft:
Motor, worm and torque measuring spring pack are all on this common shaft, which slides in direct proportion to the torque transmitted to operate the torque switch to shut off the motor.

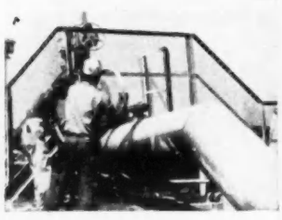
Housing:
All components taking the thrust load are housed in the base of the actuator. Those fixed directly to the valve are indestructible within the requirements of BSS 1414.

Enclosure of Electrical Equipment:
Weatherproof actuators are available, flameproof, non-flameproof, with Buxton certified motor and electrical compartments.

Geared Limit Switches:
Accurate and efficient, operated directly from the output shaft, the switches can be independently adjusted to operate at any point during valve travel.

Torque Limit Switches:
The torque switch is held closed by a coil spring and released when the pre-set torque output is reached; a set screw adjusts the tripping point.

Built-in Starter:
The integral starter illustrated is of Brookhirst Igranic block type 620, reversing contactor.



(Left and centre) Two typical overseas petroleum installations using Rotork actuators. (Right) Rotork actuators installed at the Vickers-Armstrong Hydraulic Test Plant.

Rotork have a controlling interest in all types of valves!

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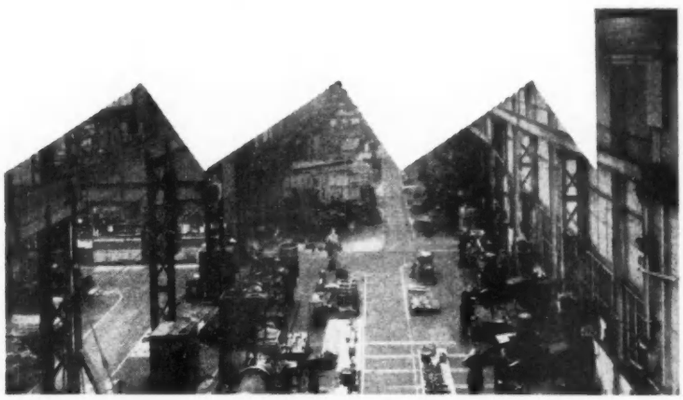
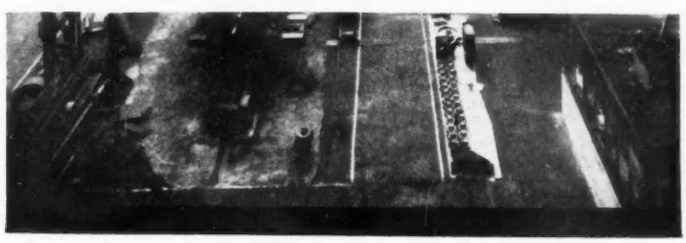
THERE'S PLANT CAPACITY AT CARRON





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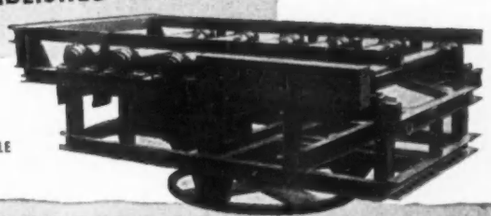

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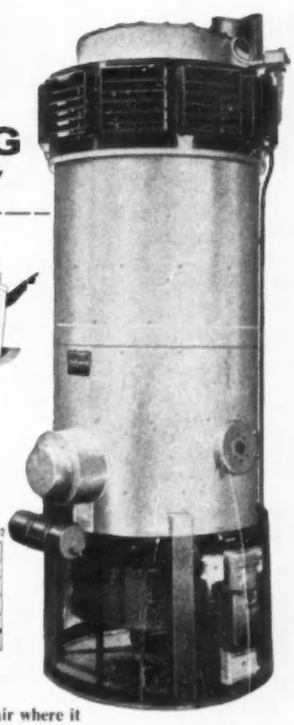

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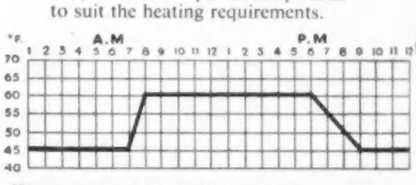

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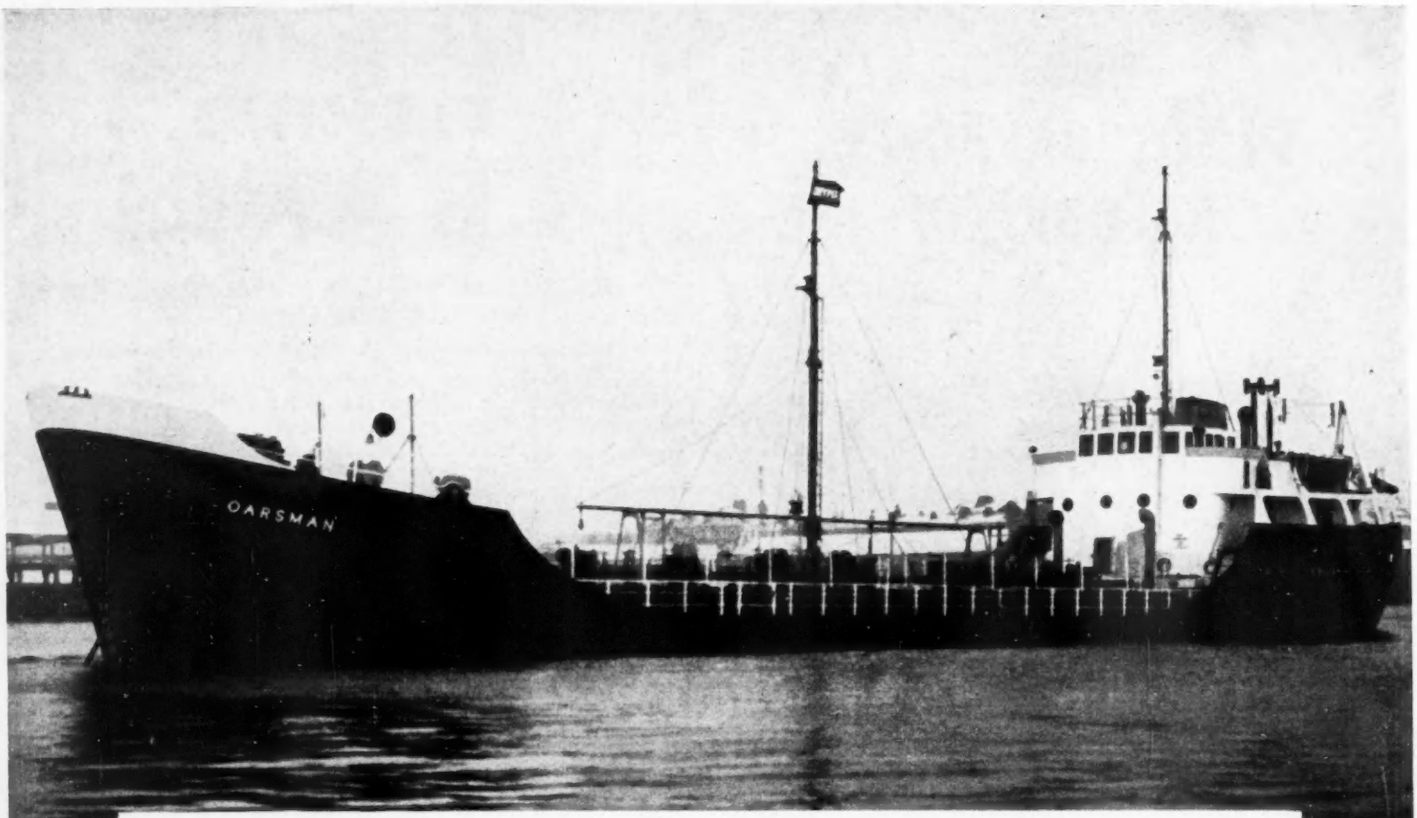

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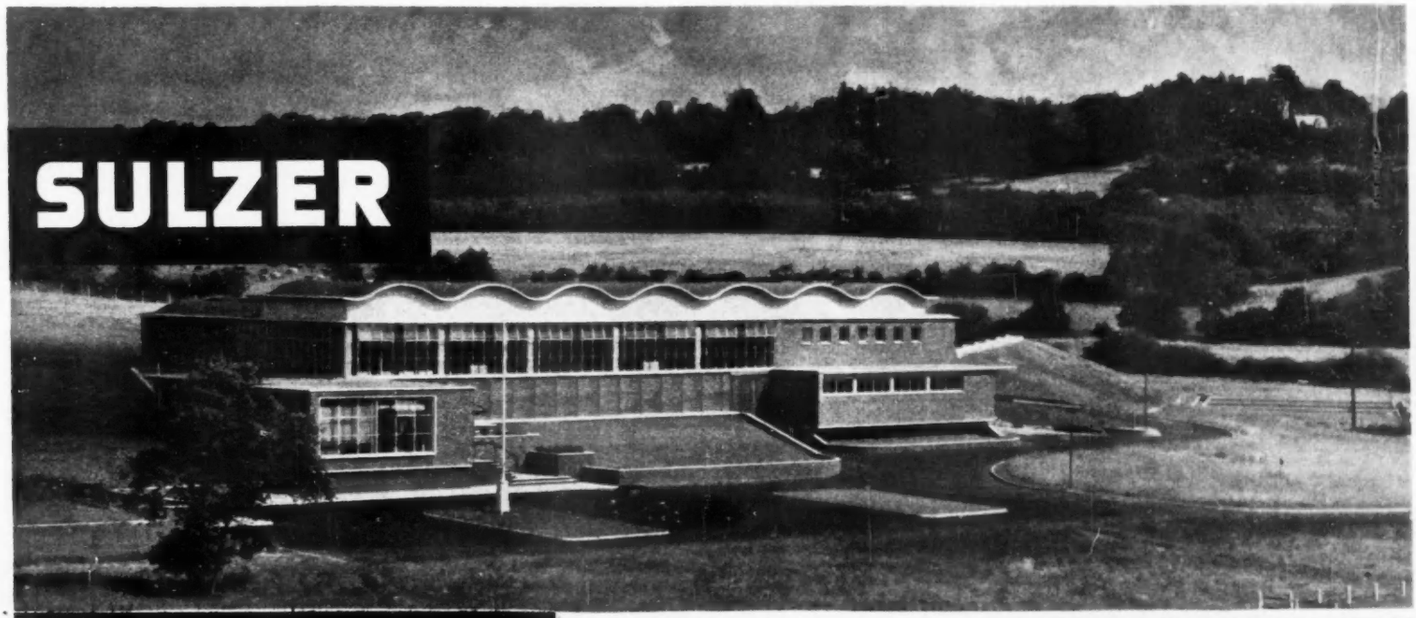

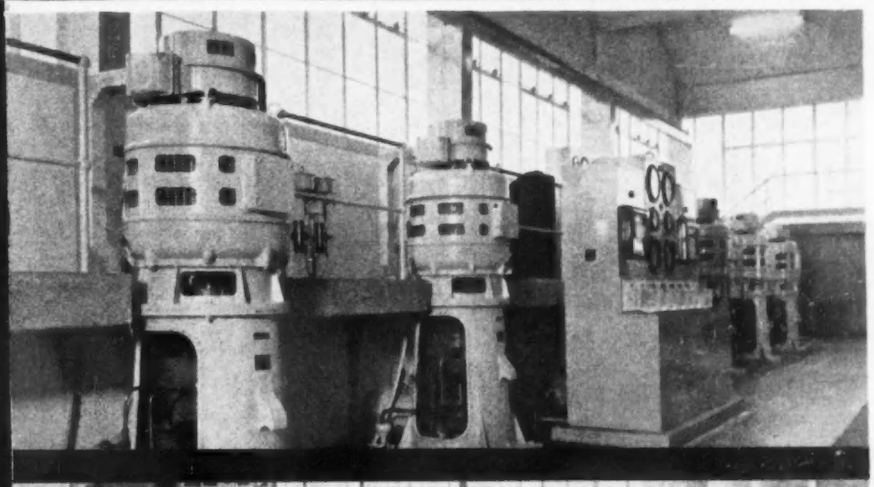

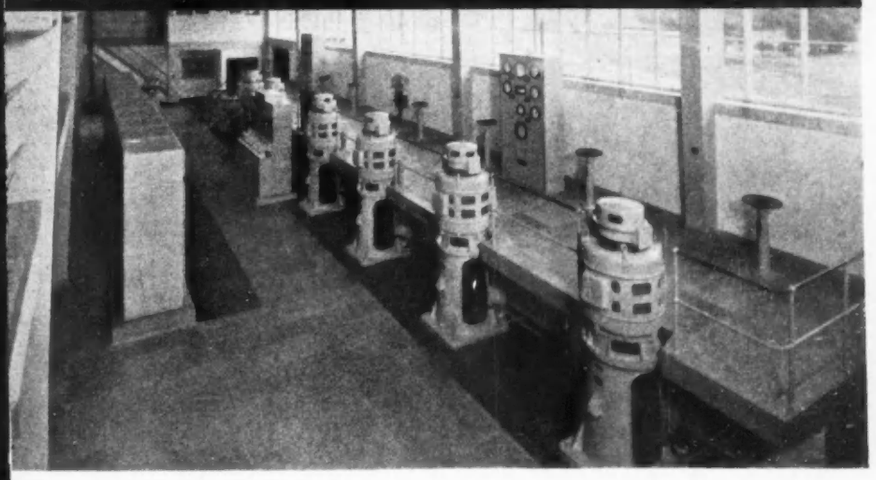

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by courtesy of E. R. Griffiths Esq., M.I.C.E., M.I.W.E., Chief Engineer.

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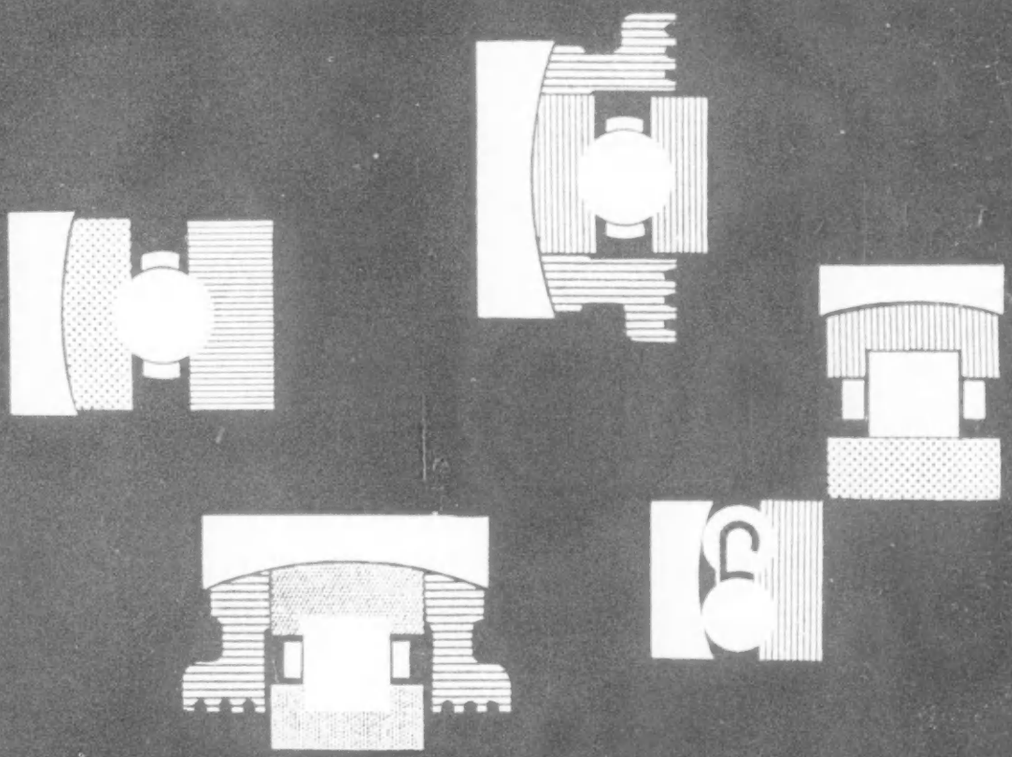

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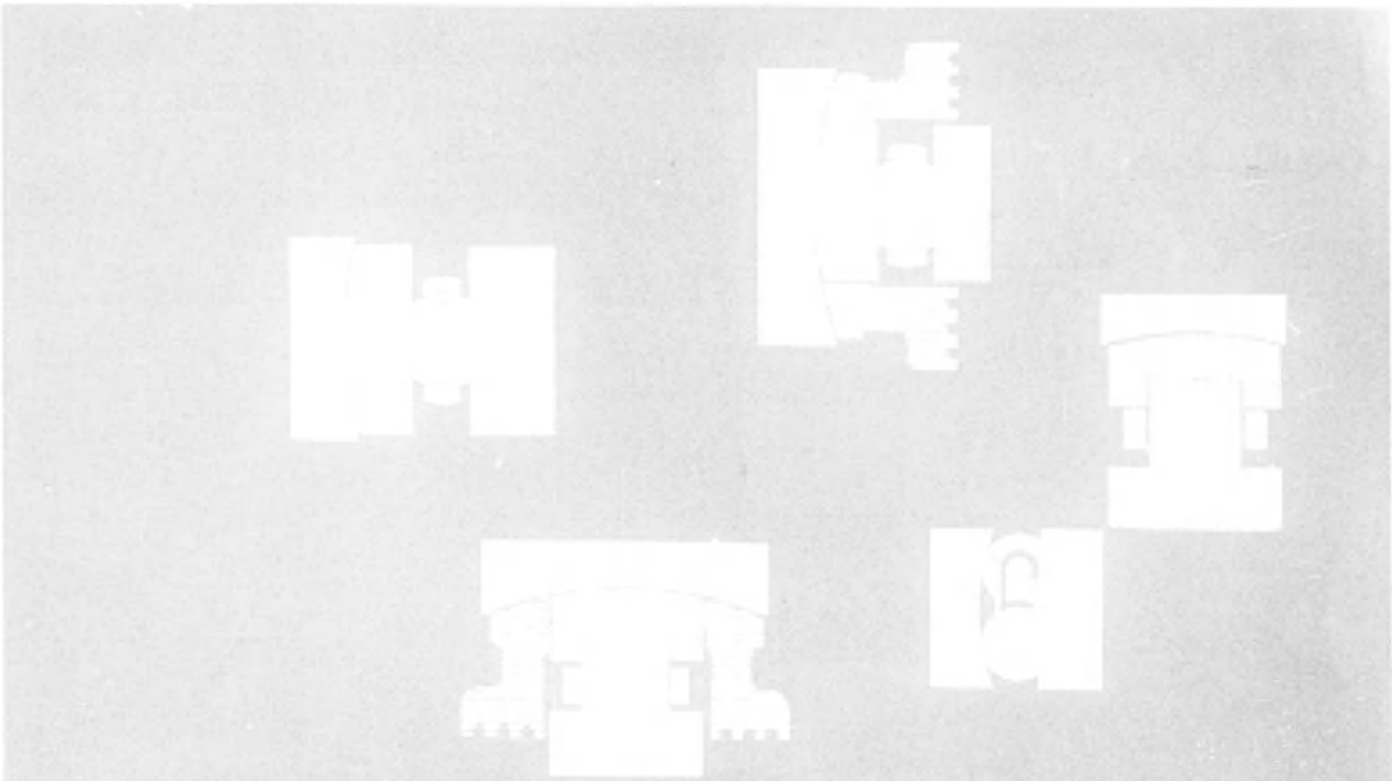

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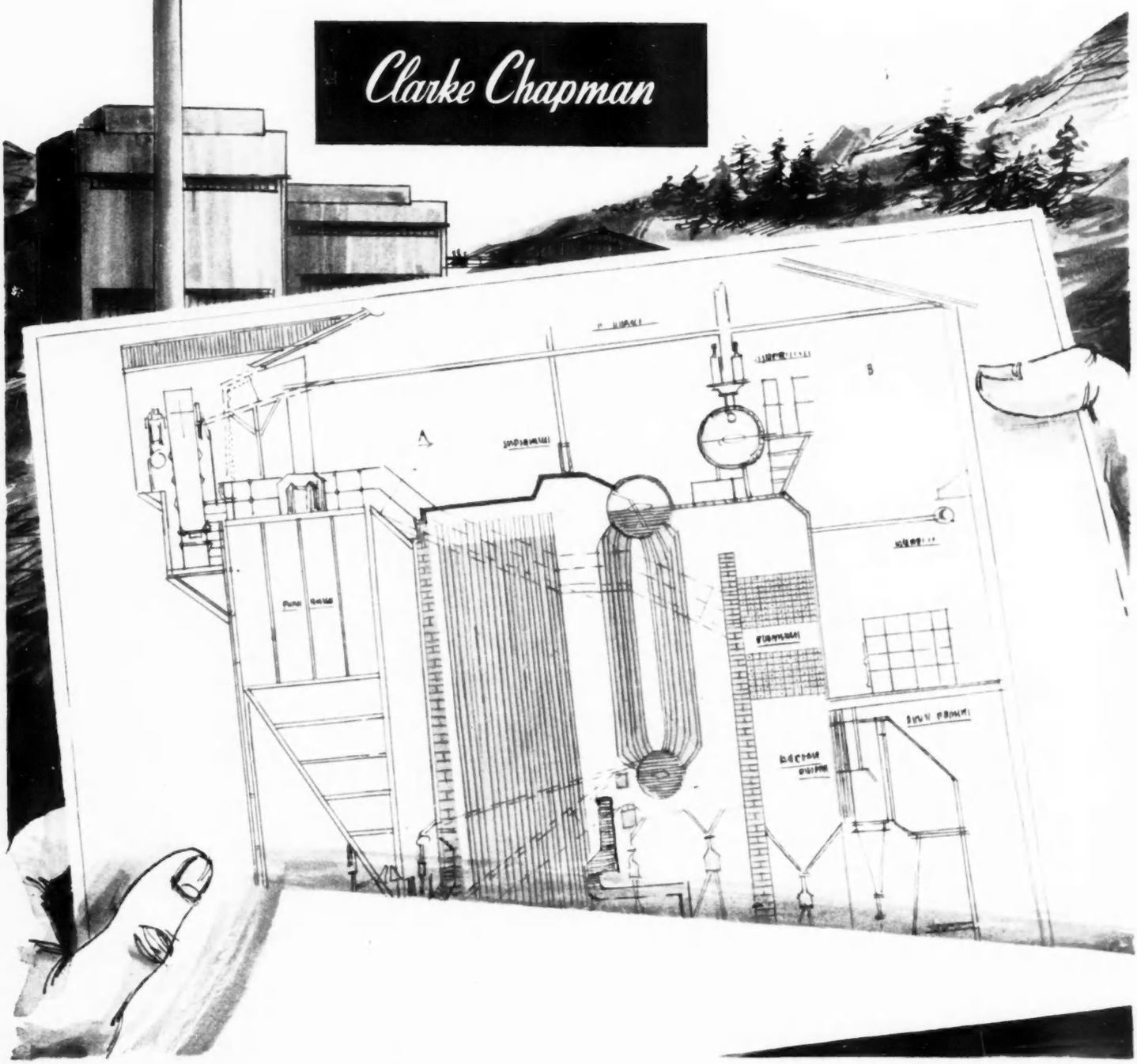

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